Michal Marciak – Marcin Sobiech – Tomasz Pirowski*

Alexander the Great’s Route to Gaugamela and Arbela

https://doi.org/10.1515/klio-2020-1005

Summary: The aim of this paper is to analyse the chronology and itinerary of the march of the Macedonian army during the last days (September 18–October 1) of the Gaugamela campaign in 331 BC in the light of literary sources, cuneiform data, topographic and archaeological data, and GIS capabilities. The overall aim of this analysis is to contribute to the topographical enigma of the identification of Gaugamela as either (in the vicinity of) Tell Gomel or Karamleis/Qaraqosh. The cuneiform data allows us to establish the most important dates of the final course of the Gaugamela campaign: the Tigris crossing on September 18, a lunar eclipse on the evening of September 20, and the battle on October 1. Furthermore, a critical analysis of Arrian and Curtius suggests that the Macedonians spent only six days on the march and four days in the camp. Given the estimated average rate of the march of the Macedonian army, it is possible to reject certain routes between the Tigris crossing and Gaugamela and consider others as more or less likely. It is concluded that the Macedonians crossed the Tigris in the vicinity of modern Basorin and not Abu Dhahir or Abu Wajnam, as is widely assumed. Furthermore, it is also demonstrated that the difference between Tell Gomel and Karamleis/Qaraqosh, regarding their distance from Arbela, is much less striking than is frequently assumed, and as such does not speak against any of the widely held identifications of Gaugamela.

Keywords: Alexander the Great, Gaugamela, Tigris Crossings, GIS

The Battle of Gaugamela, fought between the Macedonian-Greek forces led by Alexander the Great, King of Macedonia, and the Persian army under the Achaemenid King Darius III in 331 BC, has rightly been labeled as one of the most important battles in the history of the ancient world.1 Despite the great importance of this battle, its exact location is not certain and modern scholars have not agreed on a single location for the Gaugamela battlefield. Several sites have been sug-

1 Sushko 1936, 9; Marsden 1964, xi; Badian 2000, 332; Holt 2003, 73; Pietrykowski 2009, 61; and many others.

*Kontakt: Michal Marciak, E-Mail: michal.marciak@gmail.com
gested to date as the location of ancient Gaugamela, but the two most famous are definitely the Tell Gomel area² and the Karamleis/Qaraqosh region (see fig. 3).³

The aim of this paper is to contribute to the old topographical enigma of the identification of Gaugamela through the study of a very specific aspect: the chronology and itinerary of the march of the Macedonian army during the last days (September 18–October 1) of the Gaugamela campaign in 331 BC. Our analysis will correlate literary sources, cuneiform data, topographic and archaeological data, and GIS capabilities. As a result, it is hoped that we will be able to shed more light on the final days of the Gaugamela campaign by answering several questions: where and when did the Macedonians cross the Tigris river, how did they reach the battlefield, how did they proceed from the battlefield to Arbela, and why does this information matter for the famous dilemma of the identification of ancient Gaugamela?

The exact date of the Battle of Gaugamela has long been contentious because it cannot be unambiguously fixed based only on information proved by classical writers. Only two classical sources about the Battle of Gaugamela provide us with relatively detailed chronological references – Arrian and Plutarch. However, upon consideration, they turn out to contradict each other.

According to Arrian 3.15.7, the battle was fought in the month of Pyanopsion (Pyanepsion) and during the archonship of Aristophanes at Athens. This reference is closely connected with the Athenian (Attic) customs for reckoning time.⁴ Firstly, the Attic year began in summer, with the first month being called “Hekatombaion” (covering July/August), the second “Metageitnion” (August/September), and the third “Boedromion” (September/October).⁵ In turn, the month of Pyanopsion (Pyanepsion) was the fourth month, marking the beginning of autumn (October/November).⁶ Secondly, the supreme council of the Athenian state consisted of nine archons, the chief archon giving his name to the year in which he held office (much like the Roman custom of dating by consular years).⁷ The archonship of Aristophanes is attested for the years 331–330 BC.⁸

² Markwart 1905, 25; Herzfeld 1907, 128; Streck 1910; Judeich 1931, 375 f.; Marsden 1964, 18–21; Schachermeyr 1973, 266 f.; Fiey 1965, 180–185; Bosworth 1980, 293 f.; Devine 1986, 94–96; Dąbrowa 1988, 70–72; Bernard 1990, 520 f.; Reade 1998, 66; Nawotka 2010, 226; Reade – Anderson 2013, 76.
³ Droysen 1877, 330, n. 1; Tarn 1948, 35 f.; Fuller 1958, 163; Badian 2000; Zouboulakis 2014 and 2015.
⁴ Meritt 1961; Hannah 2005; Mikalson 1975.
⁵ Meritt 1961, 3–37; Mikalson 1975, 66–79; Hannah 2005, 42 f., 71–80.
⁶ Meritt 1961, 3–37; Mikalson 1975, 66–79; Hannah 2005, 42 f., 71–80.
⁷ Samuel 1972, 195–210; Develin 1989, 2 f.
⁸ Bickerman 1980, 139; Dinsmoor 1931, 359, 429; Stephenson 1997, 373.
What is more, Arrian 3.15.7 adds that Alexander’s victory took place in the same month when a near-total lunar eclipse occurred. The eclipse is already mentioned in Arrian’s description of the Macedonians’ crossing of the Tigris (3.7.5–6, but with no date), as well as by several other ancient sources (Curt. 4.10.1–7, Plut. Alex. 31.8, Plin. HN 2.180, Ptol. georg. 1.4). However, it is only Plutarch (Alex. 31.4) who gives us a detailed chronological reference to the eclipse, stating that the moon suffered an eclipse in the month of Boedromion, around the beginning of the Mysteries at Athens, and that on the eleventh night after the eclipse the armies were in sight of one another. By the Mysteries at Athens held in the month of Boedromion, the mystery cult of the Eleusinian Demeter and Persephone is certainly meant, as it was the most important Greek mystery cult and as such an event of enough social importance to provide a dating reference for other important events occurring in the same month. The mysteries officially started in Athens on the 15th of Boedromion, preceded by two days of preparations (13–14th of Boedromion), and lasted nine days. Furthermore, in another account (Cam. 19.1–8, where he lists unlucky days and famous events), Plutarch gives a precise date for the battle – the 26th day of the month of Boedromion (Plut. Cam. 19.5).

There can be no doubt that the battle could have taken place either in the month of Pyanopsion (Pyanepsion) or in the month of Boedromion. It seems that a preference for the month of Boedromion is more appropriate for chronological reasons, as dating the battle in the month of Pyanopsion (Pyanepsion) would have brought us to the middle of October – an excessively late date. What is more, it has been convincingly suggested that Arrian’s detailing of the wrong month is the result of a faulty conversion of the Macedonian month of Hyperberetaios (the last month of the Macedonian year) into the Attic calendar (in Alexander’s times, Hyperberetaios matched the Babylonian month of Ululu, but from the first century on, including Arrian’s own times, it corresponded with the later Babylonian month of Tishri).11

However, we can now be much more precise about the date of the battle and its accompanying events thanks to the cuneiform data. Namely, two cuneiform clay tablets, now stored in the British Museum, belonging to the genre of the Babylonian “Astronomical Diaries” (which record daily celestial observations and other noteworthy happenings by the specialized personnel of the Marduk

9 Bernard 1990, 516.
10 Mikalson 1975, 54–65.
11 Samuel 1972, 140–144; Bosworth 1980, 312.
12 Their existence as evidence for the campaign of Gaugamela was first raised by Wiseman 1983, 116–118.
temple in Babylon)\(^{13}\) and showing a record of events connected with the campaign of Gaugamela.\(^{16}\) The tablets in question were definitely written after the described events (as their narrative continues until Seleucid times).\(^{15}\) The tablets refer to the battle as “raising the standard” by Alexander (who is named “king of the world”) and date it to the 24th day of the sixth month (Ululu) in the fifth year of the reign of King Darius (III).\(^{16}\) This reference can be transferred into the modern Gregorian calendar as October 1, 331 BC.\(^{17}\) Furthermore, the tablets also record two other interesting events directly preceding the battle – an outbreak of panic in the camp of the (Persian) king on the eleventh day of the sixth month (Ululu) and a lunar eclipse on the thirteenth day of that month.\(^{18}\) There can be no doubt that the eclipse recorded in the “Astronomical Diaries” (dated to the night from September 20 to 21) matches the eclipse mentioned in classical sources.\(^{19}\) The identification of the outbreak of panic is not so straightforward, but it has been convincingly interpreted as the Persian reaction to the Macedonian advance, especially the Macedonian success of fording the Tigris.\(^{20}\) The chronological distance of the two events (September 18 and 20) matches the data from the classical narratives (see below).

In sum, the dating of the most important events in the campaign of Gaugamela can now be safely settled – the Macedonians crossed the Tigris on September 18, 331 BC, they saw a lunar eclipse on the evening of September 20, and the battle itself took place on October 1, 331 BC. These data are also compatible with Plutarch’s reference to eleven days between the eclipse and the encounter of the enemy troops, if we count the days in an inclusive way. Counting September 20 as the first day and September 30 as the last day, we get exactly the eleven days mentioned by Plutarch.

The question arises as to the actions undertaken by the Macedonian troops between the Tigris crossing and the battle. In this respect, it is important to look

\(^{13}\) Hunger – Sachs 1988, 11f.
\(^{14}\) See Hunger – Sachs 1988 and (with preference) Bernard 1990.
\(^{15}\) Bernard 1990, 115.
\(^{16}\) Hunger – Sachs 1988, 177–179; Del Monte 1997, 1–4; van der Spek 2003, 279; Kuhrt 2007, 447 f.
\(^{17}\) Del Monte 1997, 4; van der Spek 2003, 279; Kuhrt 2007, 447.
\(^{18}\) Hunger – Sachs 1988, 177–179; Del Monte 1997, 1–4; van der Spek 2003, 279; Kuhrt 2007, 447.
\(^{19}\) Hunger – Sachs 1988, 178; Del Monte 1997, 1; Kuhrt 2007, 447.
\(^{20}\) Bernard 1990, 517; Del Monte 1997, 4; van der Spek 2003, 298. In contrast, according to Kuhrt 2007, 448 the panic was the result of news being spread among the Persian army about the upcoming eclipse noticed in advance by the Persian “experts in observing the heavens and interpreting the phenomena (along with other omen specialists)” who were present in the Persian camp.
into our main sources, Arrian and Curtius, which provide continuous narratives about the campaign of Gaugamela.\textsuperscript{21}

In light of Arrian’s narrative, Alexander halted his troops after the Tigris crossing (ἐνταῦθα ἀναπαύει τὸν στρατόν; 3.7.6). Arrian does not specify how long the Macedonians’ stop lasted, but during this stop a lunar eclipse occurred (3.7.6). Neither does Arrian specify at which moment after the eclipse (and after having performed sacrifices to calm the worried soldiers) the Macedonians set out. According to Arrian, after four days of marching (τετάρτη δὲ ἡμέρα ἀπὸ τῆς διαβάσεως),\textsuperscript{22} the Macedonian scouts reported the presence of Persian scouting troops (3.7.7). Alexander managed to capture some Persian scouts and learn from them that the main Persian camp was not far off (οὐ πόρρω; 3.8.2). On receiving this intelligence, Alexander decided to set up a camp (surrounded by a ditch and a palisade (τὸ δὲ στρατόπεδον τάφρῳ τε καὶ χάρακι ἐτείχισεν; 3.9.1) and rest his troops (καὶ τὴν τε στρατιὰν ἐκ τῆς ὁδοῦ ἀνέπαυσε) for four days (3.9.1). After this stop, the Macedonians left their camp at about the second watch with the aim of meeting the enemy at dawn on the battlefield (3.9.2). However, having reached the hills directly overlooking the battlefield, Alexander did not decide to start the battle on that day (but rather decided to make a reconnaissance). The Macedonians are said to have made their encampment (καταστρατοπεδεύω; 3.9.4) on the hills. The battle was fought only on the next day (3.1–4).

In summary, the explicit data from Arrian’s narrative (after the Tigris crossing) points to four days of marching, four days of rest, and one day for the final approach (and reconnaissance) on the eve of the battle. Furthermore, it is also reasonable to include at least one day of rest after the Tigris crossing and before the eclipse. Thus, Arrian’s narrative takes up (at least) ten full days between the Tigris crossing and the battle and nine full days between the eclipse and the eve

\textsuperscript{21} Diodoros’ narrative is extremely condensed and as such of no use for a chronological reconstruction: the Macedonians rested one day after the crossing, on the next day Alexander led his army towards the enemy, and (next) pitched camp (καταστρατοπεδεύω) near (σύνεγγυς) the Persians (17.55.6). The description of the battle and its aftermath follows (17.56.3–17.64.3).

\textsuperscript{22} This phrase can theoretically be understood in two ways: “on the fourth day of the march from the Tigris crossing” or “on the fourth day from the time they crossed the Tigris”. The second option is, however, extremely unlikely for chronological reasons – the Macedonians would have stopped and rested for four days after only one (if counted inclusively – September 18 as the first day and September 21 as the last day) or two (if counted exclusively – September 19 as the first day and September 22 as the last day) days of marching. Furthermore, after four days of rest they would have begun their march on September 27 and would have had to spend four more days (September 27–30) on the march before the encounter with the Persian troops on September 30. See Bernard 1990, 517, n. 11; contra Burn 1952, 84 f. For different interpretations, see also Atkinson 1980, 486–488, but his overview must now be revised in light of the cuneiform data.
of the battle. The precise amount of time spent by the Macedonians in camp between the Tigris crossing and the eclipse can now be elucidated in the light of the cuneiform data: two days, not one (September 18 – the crossing, September 19–20 – in camp). Nevertheless, it has long been recognized that Arrian’s narrative suggesting a span of only nine days between the start of their march after the Tigris crossing (September 21) and the eve of the battle (September 30) creates a chronological problem – Arrian’s data does not match Plutarch’s remark (now confirmed by the cuneiform data if counted in an inclusive way) about there being eleven days between the eclipse (September 20) and the encounter of the enemy troops on the eve of the battle (September 30).

To resolve this problem, several suggestions have been put forward. First, it has been suggested that Plutarch’s expression ἑνδεκάτῃ δ' ἀπὸ τῆς ἐκλείψεως νυκτί should be corrected to ἐν δὲ δεκάτῃ νυκτί (thus giving ten and not eleven days).23 In the light of the cuneiform data, this correction is no longer acceptable. Second, it has also been speculated that Alexander let his troops rest for another day in camp, especially to make sacrifices to appease the anxiety of the soldiers,24 or possibly just to give them more rest after the commotion in the night from September 20 to 21. This would have given an additional day to Arrian’s narrative to agree with Plutarch’s eleven days (counted in an inclusive way), but does not agree with Curtius’ narrative (4.10.8: the march started immediately after the eclipse and the sacrifices, as Alexander did not want to let his soldiers dwell on the astral phenomenon for too long). Third, it has also been proposed that the “lost day” of Arrian should be sought elsewhere, 25 especially towards the end of their approach to Gaugamela; for instance, it may have taken two days and not one to reach the battlefield from the main four-day rest camp26 (again corresponding to Curtius’ narrative on this point).

In turn, in the light of Curtius’ narrative, the Macedonians rested for two days after the Tigris crossing (4.10.1). On the night before the departure from the camp, a lunar eclipse occurred around the first watch of the night (4.10.1); having brought confidence back to the soldiers (through the Egyptian soothsayers’ positive interpretation of the omens), Alexander decided to break camp in the second watch and set off (4.10.8). Curtius does not specify how long this march lasted, and the next episode in Curtius’ narrative takes place when Alexander learned from the captured Persian scouts that the Persian camp was not more than 150 stades

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23 Krause 1888, 525 f.; Marsden 1969, 75. This emendation has been accepted by Milns 1968, 180 and Green 1974, 288.
24 Beloch 1923, 315 f.; Brunt 1976, 491 f.
25 Bernard 1990, 517.
26 Bosworth 1980, 287.
distant from him, after which he stayed for four days in the same place (4.10.15). Following this rest, the Macedonians renewed their march; at some point, the Macedonians made eye contact with the Persian vanguard under Mazaeus, who occupied a small hill (*tumulus*) some distance away, whereupon the Macedonian army was seized with panic (*Alexandri exercitum pavor [...] invasit*). Alexander ordered his troops to stop and set up a fortified camp in this place (4.12.15). Only when Mazaeus abandoned the hill the next day did the Macedonians take up their positions on the hill, from which the entire Persian line of battle could be observed (4.12.18–19). Alexander decided to set up another fortified camp (*castra*) on the hill, including a palisade (*vallum*, 4.12.24). The battle took place on the next day (4.13.17, 21).

In summary, the explicit data from Curtius’ narrative points to two days of rest between the Tigris crossing and the eclipse (perfectly matching the cuneiform data); then an unknown amount of marching after the eclipse and before taking the next four days of rest in camp; and finally two days on the march before the encounter with the main body of Darius’ forces on the eve of the battle. Thus, Curtius’ narrative takes up (at least) eight full days between the Tigris crossing and the battle, and (at least) six full days between the eclipse and the battle. It is evident that the number of days spent on the march between the eclipse and the four-day rest camp is missing (and it is four days in Arrian’s narrative). If Arrian’s information concerning the four-day march after the eclipse is included, Curtius’ narrative perfectly matches both the cuneiform data and Plutarch’s remark about there being eleven days between the eclipse and the encounter with the enemy troops.

A reconstruction of the final days of the Gaugamela campaign shows that the Macedonian army spent four days inactive in camp and only six days on the march between September 21 and the battle on October 1, 331 BC. This fact bears upon our topographical question in a very specific way – it implies a certain distance between the Tigris crossing and the battlefield of Gaugamela. In this context, it is worth recalling that the average marching rate of Alexander’s troops is estimated as 24 km (15 miles) a day.27 On a given route, this estimate could of course vary depending on many specific factors (the number of troops and non-combat followers, the amount of baggage in the baggage train, the terrain and climate,

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27 Engels 1980, 56. The same estimate is given by Roth 2007, 391f. In turn, Ashley 1998, 26 (referring to both Engels 1978, 47, 55, 155 and Ferrill 1985, 183, but in fact based on the latter) gives 20.9 km (13 miles) for Alexander’s army “under normal circumstances”, 30.5 km (19 miles) “when required”, and up to 80.4 km (50 miles) for “short marches [...] of a specialized force of cavalry and light infantry”.
logistic capabilities, and the strategic situation). Nevertheless, we are speaking here about probabilities and not certainties. Furthermore, if we assume that the distance between the four-day camp and the hills overlooking the battlefield was covered in two days, and if we acknowledge Curtius’ mention of this distance as 150 stades (ca. 27.75 km), then the average rate during the last two days of the campaign was about 14 km per day. This is a considerably lower speed than the average speed widely assumed in scholarship for Alexander’s troops – 24 km per day – but it can be explained by a strategic situation that dictated an unusual degree of caution while finally approaching the Persian army. Thus, we may estimate the distance covered by Alexander’s army marching about 24 km daily as around 96 km between the Tigris crossing and the four-day camp, and a total distance of 123.75 km between the Tigris crossing and the battlefield.

One of the major problems in the identification of the final route of Alexander’s troops on the Gaugamela campaign is that the ford at which the Macedonians crossed the Tigris is not explicitly named by any ancient source. Several potential crossing points of the Tigris have been suggested in literature concerning Alexander the Great and Gaugamela: Cizre, Feshkhabur, Abu Dhahir, Abu Wajnam, and Eski Mosul. A recent study on the road network in the Upper Tigris Valley in ancient times by A. Comfort and M. Marciak has examined all possible places where the Tigris river could have been crossed in antiquity (c. 700 BC to AD 636) in southeastern Turkey and northern Iraq, especially Cizre, Feshkhabur, Basorin, Abu Dhahir, Abu Wajnam, (Eski) Mosul, and Mosul/Nineveh.

Generally speaking, the importance of this area for transportation is indicated by the Peutinger Table, which shows a road crossing the Tigris at a point called *ad flumen Tigrem* after passing by Nisibis and a line of hills (to be identified as the Tur Abdin). However, the crossing points of the Tigris in this area are a vexing issue, with regard to both the location and character of the crossings. The latter may in fact include a number of alternative modes of crossing the river, from fords

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28 According to Engels 1980, 153–156, the highest marching rate on record for Alexander’s army as a whole (including infantry) was 36.2 km (22.5 miles) per day between Paraetonium and the Ammon Oracle, and the lowest marching rate, 11.3 km (7 miles) per day, occurred between Arisbe and Percote. The highest rates of all were achieved when using only cavalry or cavalry with small numbers of other light troops – 74 km (46 miles) per day for Alexander’s cavalry chasing Darius after the Gaugamela battle (which resulted in heavy losses of horses), between ca. 60 km (37.5 miles) to 68.4 km (42.5 miles) per day from Oxus to Nautaka in Sogdiana, and ca. 69.2 km (43 miles) to 92.5 km (57.5 miles) per day between Alexandria Eschete and Maracanda in Sogdiana.

29 For very short overviews, frequently quoted in the context of Alexander’s crossing of the Tigris, see Atkinson 1980, 383; Roaf 1997. For the Macedonian crossing the Euphrates, see Gawlikowski 1996; Marsden 1969, 11–23.
to various kinds of ferries or bridges. In most cases, our data comes from much later sources and is inconclusive. Cizre and Feshkhabur are the most northern of the possibilities where the location of Alexander’s crossing of the Tigris has traditionally been suspected to have occurred.  

Around the modern city of Cizre there used to be (at least) two bridges, possibly Roman in origin but medieval in their current shape. However, only the remains of one arch of each of these bridges still exist. A British map (at 1:250,000 from 1902 of “Bohtan-Jezire”) names this bridge Pihr-a-Bahfit. The same map also points to the existence of a ford some 200 m to the south (usable only in autumn). Further downstream, a ford at Basorin (the village is now called Yankale and is located 2.5 km south of Bostancı in the Şırnak province) existed in 1836 when it was used by an English traveller, J. Shiel. In turn, Feshkhabur, although frequently mentioned in the context of Alexander’s crossing of the Tigris, is the least likely candidate for a place where the Tigris could have been forded in antiquity. First, recent research from the Eastern Ḥabur Archaeological Survey has shown that the riverbanks are steep, the current is strong, and no ford is known to local people in the area (as of 2016). Not surprisingly, early European travellers to the region (W. F. Ainsworth and A. H. Layard) spoke only of the ferry crossing at Feshkhabur. Two modern scholars (L. H. Dillemann and M. Fiey) have suggested the existence of a bridge, although they did not visit the site and apparently relied on a mistaken observation made by J. Černík. The Eastern Ḥabur Archaeological Survey found no extant remains that could be interpreted as traces of an ancient bridge nor was any infrastructure found that could be related to a Tigris crossing (such as those at Abu Dhahir and Abu Wajnam). Thus, it appears that the crossing of the Tigris at Feshkhabur always took place by ferry.

Further downstream, two important crossing points of the Tigris have been suggested as fords by A. Stein, Abu Dhahir and Abu Wajnam, which are both now beneath the waters of the Eski Mosul Dam. Both topographical and archaeological premises speak in favour of these locations as fords in antiquity and both locations are situated where the terrain allows direct access to the Tigris riverbed through the hills flanking the southern course of the Tigris (which is particularly visible for Abu Wajnam even on small-scale maps). In terms of archaeological evidence, the use of the vicinity of Abu Dhahir and Abu Wajnam as crossing points seems to be corroborated by the extant remains of nearby fortresses controlling approaches to these locations – Seh Qubba in the case of Abu Dhahir, as well as two possible Roman castella near Qabaq (identified by A. Stein but no
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longer preserved) and a recently discovered site (by the Land of Nineveh Archaeological Project) named Chamarash for Abu Wajnam. The existence of the ford at Abu Wajnam may also be confirmed by J. Kinneir, who travelled from Cizre via Zakho to Mosul in 1813, while the local use of the ford at Abu Dhahir was also reported by British excavators in the 1980s.

Eski Mosul (known as Balad or Shahrabadh before the Arab conquests) has also been suggested as a possible crossing point for Alexander’s troops. Its current name, derived from Turkish (“Old Mosul”), suggests that the place was occupied before the foundation of the Arab Mosul (49 km southeast of Eski Mosul) by the Ummayads in the 7th century CE. A. Stein’s investigation indicates that the crossing of the Tigris at Eski Mosul took place by ferry or pontoon bridge. The remains reported by A. Stein also included an ancient roadway, possibly ancient blocks in the foundations of the medieval city wall, remains of the medieval bridge (a perfect high semi-circular arch) crossing the Wadi-al-Murr, and a Roman *castellum*. However, nothing specific indicates the existence of a ford at Eski Mosul, where the Tigris was most likely crossed by ferry or a pontoon bridge. In turn, Mosul (as the site of medieval and modern occupation) and Nineveh (as the site of the ancient city) are widely held to have been situated at a crossing of the Tigris in antiquity. Mosul’s antecedents (on the west bank of the Tigris opposite Nineveh) in antiquity are unclear, but literary evidence (Arabic sources including Al-Tabari and Al-Baladhuri), as well as isolated epigraphic and ceramic findings, point to the existence of Sasanian and Late-Roman fortresses apparently guarding approaches to the Tigris. At any rate, Benjamin of Tudela confirms the existence of a bridge, at least partly built on pontoons, in Mosul in the 12th century CE.

In this context, it is important to reflect on the distances between the suggested crossing points of the Tigris by Alexander’s troops and the suggested identifications of the battlefield of Gaugamela. In practice, such distances are frequently estimated by scholars as either Euclidean metric (as “the crow flies”) or by analogy of modern travel. Given the obvious disadvantages of these two approaches, this paper seeks to employ a different method of estimating the probable distances covered by the Macedonian troops between September 21 and 30,
331 BC – the “least cost path” analysis used in Geographic Information Systems (GIS).\(^{36}\)

The “least cost path” is a method of finding the route over a surface from point A to B that has the least cost accumulated along the way; the idea of cost does not necessarily mean financial cost, but some composite measure that may depend on many factors (defined by attributes of cells being, e.g. degree of slopes, type of land cover and existence of blockades).\(^{37}\) For the purpose of our analysis, the basic data source was a digital elevation model (DEM) provided by the Shuttle Radar Topography Mission (SRTM)\(^{38}\) of 100 m resolution\(^{39}\) and a drainage system reconstructed from the DEM and satellite imagery and enriched by topographic maps called Tactical Pilotage Charts (TPC) at 1:500,000. A map of local land slopes was created based on the DEM, with slopes classified in the form of 68 intervals of one degree. The lowest interval was weighted 1 (meaning less cost), while the highest was 68 (denoting more cost). The drainage system was classified into three types of watercourses with different point weights: large perennial watercourses (Tigris, Great Zab) – 1,000, other perennial watercourses – 25, and ephemeral watercourses – 10. The aforementioned values should be understood as the increasing difficulty of travel, translating into an increase in the time/
decrease in the speed of the march. The slope model and the drainage system model have been combined to form a common base model used to analyse the “least cost paths” between chosen locations.\footnote{Given the lack of precise data on marching techniques in ancient times, more advanced methods of estimating travel time (for which, see Herzog 2014) were not used.}

The following results have been achieved (see fig. 1, 4–5): Cizre – Tell Gomel: 163.0 km, Basorin – Tell Gomel: 133.4 km, Feshkhabur – Tell Gomel: 128.8 km, Abu Dhahir – Tell Gomel: 97.1 km, Abu Wajnam – Tell Gomel: 72.8 km, Eski Mosul – Tell Gomel: 75.3 km, Mosul – Tell Gomel: 47.9 km, Cizre – Karamleis: 179.7 km, Basorin – Karamleis: 154.3 km, Feshkhabur – Karamleis: 143.7 km, Abu Dhahir – Karamleis: 112.1 km, Abu Wajnam – Karamleis: 87.8 km, Eski Mosul – Karamleis: 72.9 km, Mosul – Karamleis: 27.1 km.

If we compare the chronological data on the time spent by the Macedonian army on the march (four days of marching covering on average 24 km daily, which gives 96 km plus 27.75 km during the last two days, that is 123.75 km altogether for six marching days between September 21 and 30) with the distances between the suggested crossing points of the Tigris and the well-known identifications of Gaugamela, several conclusions become apparent.

1. The shortest routes between the Tigris crossings and Tell Gomel/Karamleis are extremely unlikely, as they both imply a very low speed for the Macedonian army and an excessive amount of rest, two things that contrast sharply with what we know about the logistic capabilities and customs of Alexander’s army. This refers especially to the Mosul – Karamleis (27.1 km) and Mosul – Tell Gomel (47.9 km) routes, as both imply a ridiculously low speed for the Macedonian army. To be precise, the route from Mosul to Karamleis is too short even for the distance of 27.75 km covered by the Macedonians during the last two days according to Curtius 4.10.15, not to mention four days of marching between 21 and 24 September (which could cover ca. 96 km). In turn, the Mosul – Tell Gomel route (47.9 km) would suggest an average marching rate of 5.0 km daily to cover 20.15 km between September 21 and 24.

2. Not surprisingly, there is no single route that perfectly matches the distance suggested by our chronological considerations. The route that is closest to our assumptions is the one between Feshkhabur and Tell Gomel (128.7 km in total, with an average marching rate of 25.2 km daily to cover 101 km between September 21 and 24). Feshkhabur is, however, problematic as the location of the ford in antiquity (see above).

3. However, given the approximation of our calculations, especially the use of the average marching rate, it may be advisable to use a margin of error of at
least 10% for the average marching rate of 24 km per day. If so, the expected distance would be enlarged from 123.75 km to between 135 and 111 km. In this case, next to the Feshkhabur – Tell Gomel route, two other routes come into play: Basorin – Tell Gomel (133.4 km in total, with an average marching rate of 24.4 km daily to cover 105.6 km between September 21 and 24) and Abu Dhahir – Karamleis (112.1 km in total, with an average marching rate of 21.1 km daily to cover 84.3 km between September 21 and 24).

4. If the margin of error is enlarged to 20% (99–148.5 km), one route becomes another candidate (Feshkhabur – Karamleis: 143.7 km in total, with an average marching rate of 29.9 km daily to cover 115.9 km between 21 and 24), and a second falls short of the margin of error (Abu Dhahir – Tell Gomel: 97.1 km in total, with an average marching rate of 17.3 km daily to cover 69.3 km between September 21 and 24).

5. It seems that all other routes that are longer or shorter than our criteria are less probable than the routes mentioned above. In this group, seven routes can be mentioned, and they can all be further divided into two subgroups depending on whether they envisage a longer or shorter distance. First, the ‘longer’ group includes the routes of Cizre – Karamleis (179.7 km in total, with an average marching rate of 37.9 km daily to cover 151.9 km between September 21 and 24), Cizre – Tell Gomel (163.0 km in total, with an average marching rate of 33.8 km daily to cover 135.3 km between September 21 and 24), and Basorin – Karamleis (154.3 km in total, with an average marching rate of 31.8 km daily to cover 127.0 km between September 21 and 24). Second, the ‘shorter’ group includes the routes Abu Wajnam – Karamleis (87.8 km in total, with an average marching rate of 15.00 km daily to cover 60.0 km between September 21 and 24), Eski Mosul – Tell Gomel (75.3 km in total, with an average marching rate of 11.9 km daily to cover 47.6 km between September 21 and 24), Eski Mosul – Karamleis (72.9 km in total, with an average marching rate of 11.3 km daily to cover 45.1 km between September 21 and 24), and Abu Wajnam – Tell Gomel (72.8 km in total, with an average marching rate of 11.3 km daily to cover 45.0 km between September 21 and 24). In this context, the question arises as to which routes, longer or shorter, are most likely, if any. On the one hand, the average marching rate of the Macedonians during the last two days of the Gaugamela campaign in the light of Curtius, being 14 km, may speak in favour of the shorter routes. On the other hand, the average speed of 14 km on September 29–30 must have been connected with a strategic situation dictating an unusual degree of caution while finally approaching the battlefield. Furthermore, the fact that the Macedonians spent as many as four days in camp and Arrian’s explicit explanation of this stop as aiming to rest the troops may indicate that there was a need
for such rest, which is hard to reconcile with a lower than average marching rate. In this light, the longer routes of the Macedonian troops on September 21–24 should be seriously considered. In fact, while an average marching rate of 37.99 km daily to cover 151.9 km from Cizre towards Karamleis would not have been an easy task to undertake, and the average marching rate of 33.8 km daily to cover 135.3 km from Cizre towards Tell Gomel would have been a doable though again not easy task, likewise the average marching rate of 31.8 km daily to cover 127.0 km from Basorin towards Karamleis is plausible. Finally, given the rest of the Macedonians on September 25–28, it is much more difficult to assume that the distance covered before setting up the camp was considerably shorter than average, which speaks against all routes starting at Eski Mosul and Abu Wajnam.

Another important problem for the identification of Gaugamela is the distance between the battlefield and Arbela. First and foremost, the two most well-known references to the location of the Battle of Gaugamela are Arrian (Arr. 3.15.5, 6.11.4–6) and Curtius Rufus (Curt. 4.9.9–10). According to Arrian (Arr. 3.15.5, 6.11.4–6), the battlefield was located about 600 or 500 (two slightly different traditions quoted by Arrian) stades from Arbela (modern Erbil), which equals ca. 111 or 92 km. By contrast, according to Curtius Rufus (Curt. 4.9.9–10), the battlefield was 60 stades away from the Lykos River (at the point where the Persians crossed it), which equals ca. 11 km. For the sake of providing a parallel, the two most frequently used modern crossings of the Lykos River (that is, the modern Great Zab River) at Eski Kelek and Al Kuwayr are located only 23.9 km and 32.2 km (the “least cost path” analysis, see below) away from Erbil, respectively.

The discrepancy between these two references has been recognized ever since the beginning of the search for the location of the Battle of Gaugamela. However, the question that is of interest to us here is of a logistic nature.

According to Arrian, Alexander crossed the Lykos River in his pursuit of Darius and stopped (ἀναπαύω) there, giving rest to his men and horses (3.15.5). Towards midnight (ἐπὶ μέσας νύκτας), Alexander again set out towards Arbela, which he reached on the next day (τῇ ὑστεραίᾳ; 3.15.5). It is not precisely stated at what time he reached Arbela the next day. Thus, according to Appian 3.15.5, Alexander covered 600 stades in his pursuit of Darius. To be more precise, he apparently covered this distance in two stages, the second stage being of imprecise duration and possibly much longer than the first stage (lasting only until midnight). Arrian adds (3.15.6) that over a thousand Macedonian horses perished both from the battle engagement and the pursuit, among these nearly half of the horses of Alexander’s unit (the Companions). In turn, Curtius does not provide details about Alexander’s pursuit of Darius III as Arrian does. However, he
remarks that Darius III covered a great distance (ingens spatium) on his escape from Gaugamela to Arbela, which he reached around midnight (4.16.9).

The question of the route between Gaugamela and Arbela is also connected with the issue of river crossings in the area. According to both Curtius (4.9.9, 4.16.8, 4.16.16) and Arrian (3.15.4), this route led through the Lykos River, which Darius III decided to bridge while preparing for the battle. This bridge was used by the Persian army on its way to Gaugamela and by both Alexander and Darius III when heading for Arbela after the battle. There is no doubt that the Lykos River can be identified with the modern Great Zab, but, as in the case of the Macedonians crossing the Tigris, the location of the Lykos crossing is not explicitly named by any ancient source. Therefore, we have to rely on our knowledge of the Great Zab crossings in antiquity.

If Gaugamela is to be located in the Navkur Plain, then Gaugamela would most likely have been connected with a Lykos crossing via a route running more to the north (further away from the Tigris Valley) than to the south (close to the Tigris Valley). Accordingly, a more upstream crossing of the Great Zab River would also have been used to reach Arbela. In this context, two locations of the Great Zab crossing have been suggested so far: Gird-i Mamik and Chammah (see fig. 6).

Concerning Gird-i Mamik, J.-M. Fiey claimed that traces of masonry belonging to the bridge were still visible at Gird-i Mamik in the bed of the river and on both banks (he saw them in person in 1950). As reported by Fiey, the remains in the bed of the river would suggest one or more piers between the arches. Following this clue, J. Reade reports that upon his request Gird-i Mamik was visited by A. Abbas, who was not able to locate any remains of a bridge. However, according to Abbas, local informants claimed that there had once been “an arched gate leading into a large town beside the river”. In the opinion of Reade, “the story of an arch sounds suspiciously as if it may refer to the final remnant of an arched bridge, no longer recognized as such.” It should be stressed that Gird-i Mamik has never been suggested as a convenient place for a ford (the Land of Nineveh Archaeological Project [LoNAP] reconnaissance in October 2016 and September 2018 found the riverbed at Gird-i Mamik to be deep). Furthermore, because of the presence of high hills on the western bank of the Tigris, the approach towards Tell Gomel would have led via the vicinity of modern Dahlare, located several hundred meters south of Gird-i Mamik. In this light, Gird-i Mamik (Dahlare) could have been a place where Darius built a bridge on the Great Zab as a one-time

41 Marciak 2014, 180–182; Marciak 2017, 164 f.
42 Fiey 1965, 183.
43 Reade – Anderson 2013, 77 f.
44 Reade – Anderson 2013, 78.
decision connected with his preparations for the final battle against Alexander
the Great, but a common transportation route over the Great Zab in the area of
the northern course of the river must have taken place through other means, most
likely by ford. In this context, Chammah (located ca. 12 km to the north) comes
into play as a possible location for a ford – at Chammah, the stream of the Great
Zab is wide and the level of the water is relatively low. What is more, the align-
ment of sites discovered both in the LoNAP and Upper Greater Zab Archaeological
Reconnaissance licensed areas may suggest this as line of transportation between
the Navkur Plain (around Tell Gomel) and the upper course of the Great Zab area
(around Chammah).45 If, alternatively, Darius’ bridge was built at Chammah, its
aim would have been to considerably speed the Persian army’s transport (includ-
ing its train) across the river, as compared to crossing it by ford (as does the
modern bridge at Chammah despite low levels of water).

If the Battle of Gaugamela took place in the Karamleis Plain, then it would
have been naturally connected with a Lykos crossing via a southern route located
close to the Tigris Valley, like the one used by the Greek army of the Ten Thousand
in 401 BC. In this context, three locations have been suggested by scholars for a
ford crossing of the Great Zab (see fig. 7): first, just below Eski Kelek by the village
called Zeilan (36°15′58″N, 43°36′28″E); second, below the junction of the Great Zab
with the Khazir (36°09′32.8″N, 43°32′32.1″E); third, immediately above the con-
fluence of the Greater Zab with the Tigris.46 Again, in the case of the Gaugamela
campaign, we should look for a location for the Great Zab crossing where Darius’
bridge was built. In this respect, most supporters of the southern location of the
Gaugamela battle have pointed to routes leading via modern crossings at Eski Kelek
(A. Stein) or Al Kuwayr (A. Sushko) on the Great Zab.47 In addition, one could con-
sider crossing points of the Great Zab at Wardak (approximately at 36°10′44.2″N,
43°32′37.3″E) and Gaetli (approximately at 36°09′32.8″N, 43°32′32.1″E), which are
indicated as fords by the J38T Mosul Map from 1942. In view of the lack of archae-
ological data from the area, these identifications may be argued for only on the
grounds of the general continuity of the terrain features throughout the ages.

The following results of the “least cost path” analysis between the chosen
locations have been achieved (see fig. 2, 6–7): Tell Gomel to Arbela via Chammah:
77.7 km (including 36.9 km between Tell Gomel and Chammah and 40.8 km
between Chammah and Arbela); Tell Gomel to Arbela via Dahlare: 71 km (includ-
ing 37.7 km between Tell Gomel and Dahlare and 33.6 km between Dahlare and

45 Details remain to be published. For the LoNAP research, see Bonacossi – Iamoni 2015; for
the UGZAR project, see http://archeo.amu.edu.pl/ugzar/indexen.htm, (last accessed 09.07.2020).
46 For a summary, see Reade 2015, 192.
47 Sushko 1936, 172; Stein 1942, 160 f.
Arbela); Karamleis to Arbela via (Manquba and) Eski Kelek: 62.7 km (including 13.1 km between Karamleis and Manquba, 10.8 km between Manquba and Eski Kelek, and 38.9 km between Eski Kelek and Arbela); Karamleis to Arbela via Wardak: 66.8 km (including 21.2 km between Karamleis and Wardak and 45.6 km between Wardak and Arbela); Karamleis to Arbela via Gaetli: 67.2 km (including 20.6 km between Karamleis and Gaetli and 46.5 km between Gaetli and Arbela); Karamleis to Arbela via Al Kuwayr: 89.5 km (including 32.2 km between Karamleis and Al Kuwayr and 57.3 km between Al Kuwayr and Arbela).

These results are a little surprising. First of all, it should be noted that none of the distances between the well-known alternative locations of the battlefield (Tell Gomel versus Karamleis/Qaraqosh) and Arbela perfectly match the expectations formed on the basis of literary sources. For Tell Gomel and Arbela, the distance is considerably shorter (77.7 or 71 km) than suggested by Arrian (Arr. 3.15.5, 6.11.4–6: 600 or 500 stades, which equals ca. 111 or 92 km). In the case of Karamleis, we actually have to compare the distances between the crossing point of the Lykos and the battlefield (60 stades = 11 km), and the distances turn out to be a great deal longer than those suggested by Curtius – Karamleis can be reached via Eski Kelek (and Manquba) after 23.9 km, via Wardak after 21.2 km, via Gaetli after 20.6 km, and via Al Kuwayr after as many as 32.2 km. It follows that (unless the location of the Gaugamela battlefield should be sought somewhere other than at Tell Gomel/Karamleis) we cannot take measurements provided by ancient authors too literally. Furthermore, although it has been frequently assumed that the biggest weakness of the Tell Gomel identification lies in its distance from Arbela, it turns out that this distance is not much longer than the distance between Karamleis and Arbela via Eski Kelek (as advocated by A. Stein) – 15 km via Chammah or only 8.3 km via Dahlare.

In summary, more light can nowadays be shed on the notorious topographical enigma of the location of the famous Battle of Gaugamela if chronological data in ancient sources is confronted with knowledge of local topography and archaeology and the modern capabilities of GIS. Namely, the Babylonian “Astronomical Diaries” allow us to establish the most important dates of the final course of the Gaugamela campaign: the Tigris crossing on September 18, 331 BC, a lunar eclipse on the evening of September 20, 331 BC, and the Battle of Gaugamela on October 1, 331 BC. Furthermore, a critical and comparative analysis of literary sources, those of Arrian and Curtius, suggests that the Macedonians spent only six days on the march (September 21–24 and September 29–30) and four days in camp (September 25–28). Given Curtius’ information on the distance covered by the Macedonians on September 29–30 (150 stades ≈ 27.75 km) and the estimated (by D. Engels) average marching rate of the Macedonian army (24 km daily), it is possible nowadays to say much more about the itinerary of the Macedonian army...
during the final days of the Gaugamela campaign. In this context, the results of the GIS analysis of the ‘least cost paths’ (based on topographical and archaeological data from the region) have been confronted with the chronological information gained from ancient sources. With this data, it becomes clear that, first, the Mosul – Tell Gomel/Karamleis routes (as recently advocated by K. Zouboulakis\textsuperscript{48}) are extremely unlikely (as implying radically short distances covered over a long period of time); second, the short routes from Eski Mosul and Abu Wajnam are very unlikely for the same reason; and third, all longer routes (Cizre, Basorin, Feshkhabur, Abu Dhahir) are likely, with a special preference for the Tigris crossing at Basorin. Finally, the problem of Alexander’s one-day pursuit of Darius III after the battle in relation to the distance between Gaugamela and Arbela can also be alleviated. In this context, it can be stated that the information about post-battle manoeuvres given by ancient authors cannot be taken too literally, and the difference between the northern location (Tell Gomel) and the southern location (Karamleis/Qaraqosh) concerning their distance from Arbela is much less striking than frequently assumed, and as such does not speak against any of the widely held identifications of Gaugamela.

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\textsuperscript{48} Zouboulakis 2016, 443f.
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## Appendix

| Route                          | Total – km |
|-------------------------------|------------|
| Tell Gomel – Cizre             | 163.0      |
| Tell Gomel – Abu Dhahir       | 97.1       |
| Tell Gomel – Abu Wajnam       | 72.8       |
| Tell Gomel – Basorin          | 133.4      |
| Tell Gomel – Eski Mosul       | 75.3       |
| Tell Gomel – Feshkhabur       | 128.8      |
| Tell Gomel – Mosul             | 47.9       |
| Karamleis – Abu Dhahir        | 112.1      |
| Karamleis – Abu Wajnam        | 87.8       |
| Karamleis – Basorin           | 154.3      |
| Karamleis – Eski Mosul        | 72.9       |
| Karamleis – Feshkhabur        | 143.7      |
| Karamleis – Mosul             | 27.1       |

**Fig. 1:** Length of routes between the Tigris crossings and Tell Gomel/Karamleis

| Route                  | Length – km | Route                          | Total – km |
|------------------------|-------------|-------------------------------|------------|
| Tell Gomel – Chammah   | 36.9        | Tell Gomel to Arbela via Chammah | 77.7       |
| Chammah – Erbil        | 40.8        |                               |            |
| Tell Gomel – Dahlare   | 37.7        | Tell Gomel to Arbela via Dahlare | 71.3       |
| Dahlare – Erbil        | 33.6        |                               |            |
| Karamleis – Manquba    | 13.1        | Karamleis to Arbela via Eski Kelek and Manquba | 62.8 |
| Manquba – Eski Kelek   | 10.8        |                               |            |
| Eski Kelek – Erbil     | 38.9        |                               |            |
| Karamleis – Al Kuwayr  | 32.2        | Karamleis to Arbela via Al Kuwayr | 89.5       |
| Al Kuwayr – Erbil      | 57.3        |                               |            |
| Karamleis – Gaetli     | 20.6        | Karamleis to Arbela via Gaetli | 67.1       |
| Gaetli – Arbela        | 46.5        |                               |            |
| Karamleis – Wardak     | 21.2        | Karamleis to Arbela via Wardak | 66.8       |
| Wardak – Arbela        | 45.6        |                               |            |

**Fig. 2:** Length of routes between Tell Gomel/Karamleis and Arbela
Fig. 3: Topography of Northern Iraq and Licence Area of the Land of Nineveh Archaeological Project (© M. Marciak – M. Sobiech – T. Pirowski)

Fig. 4: Potential routes from the Tigris crossings to Tell Gomel (© M. Marciak – M. Sobiech – T. Pirowski)
Fig. 5: Potential routes from the Tigris crossings to Karamleis (© M. Marciak – M. Sobiech – T. Pirowski)

Fig. 6: Potential routes from Tell Gomel to Arbela (© M. Marciak – M. Sobiech – T. Pirowski)
Fig. 7: Potential routes from Karamleis to Arbela (© M. Marciak – M. Sobiech – T. Pirowski)