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TWO LAGOMORPHS, FROM THE PLIOCENE OF MACEDONIA,GREECE

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ABSTRACT

Two different lagomorphs from the Pliocene locality of "Megalo Emvolon" (Macedonia, Greece) are studied. The locality is situated 25 km southern to Thessaloniki, near the cap of Megalo Emvolon. The deposits are continental and consist of sands, gravels, sandstones alternated with sand-silts and red-beds. Three different fossiliferous levels were distinguished, "Megalo Emvolon 1,2,3" or MEV, MEM, MEL. The studied material were found in the locality MEV near the bottom of the outcrop. The found lagomorphs belong to *Trischizolagus* and they described and compared with the known material. The first form is large-sized with well developed mesoflexid and it has determined to *T. dumitrescuae* RADULESCO & SAMSON, 1967. The other is small-sized and it is referred as *T.* cf. *maritsae*. The locality is dated to late Pliocene, MN15.

INTRODUCTION

The Pliocene mammalian localities of Greece are few and their faunas are still poorly known. One of the known Pliocene localities with micro- and macro-mammals is that of Megalo Emvolon, situated about 25 Km southern to Thessaloniki , near the cap of Megalo Emvolon (Fig. 1a). The fossiliferous deposits of the area were known from the beginning of this century when Arambourg collected some fossils. This collection was later studied and the species "*Hipparion gracile*"(=*Hipparion longipes*), *Parabos makedoniae*, *Gazella bailloudi* and *Testudo* sp. were determined (ARAMBOURG & PIVETEAU, 1929). Later some

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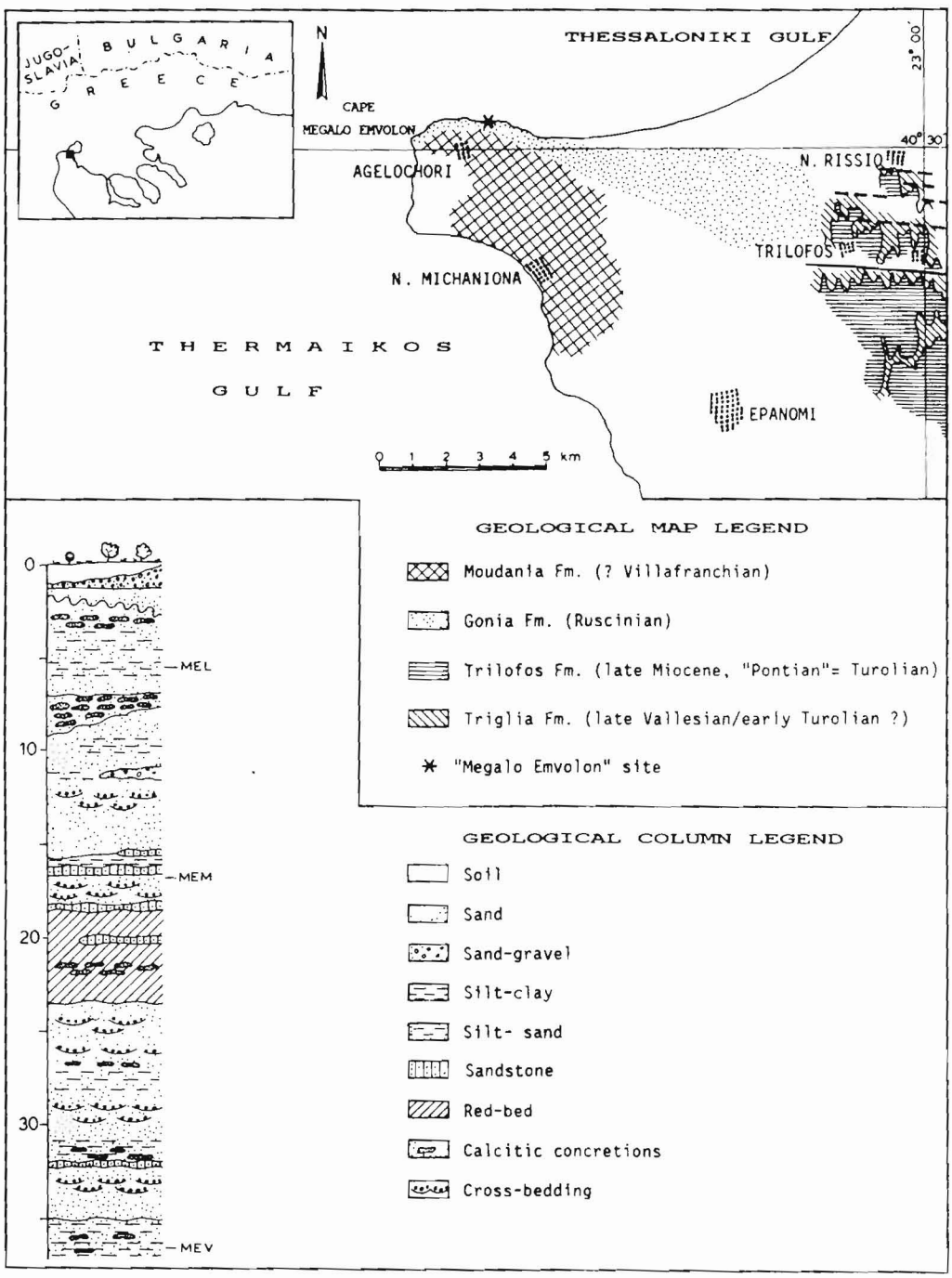


Fig. 1. **a.** *Geological map of the Megalo Emvolon area with the Neogene / Quaternary formations.* **b.** *Stratigraphical column of Megalo Emvolon (after KOUFOS et al., 1991).*

new material has been collected and described by several authors. The species *Hipparion longipes*, *Sus minor*, *Spalax odessanus*, *Oryctolagus* cf. *laynensis* and *Trischizolagus* cf. *maritsae* were referred from Megalo Emvolon without description by STEFFENS *et al.* (1979). Two turtles, *Testudo* cf. *graeca* and another large-sized one referred as *Testudo* sp. were described from the area (BACHMAYER *et al.*, 1980). Recently the mole-rat *Microspalax odessanus* was found and described by DE BRUIJN (1984).

During the last three years a team from the Laboratory of Geology and Palaeontology of the University of Thessaloniki led by G. Koufos begun to investigate the area of Megalo Emvolon. More than 5 fossiliferous sites have been found but some of them are very high in the vertical wall of the outcrop and it is impossible to reach them. Some material has been collected from three localities, which represent small and poor concentrations. These localities are situated in three different stratigraphic levels (Fig. 1b). The lower locality ("Megalo Emvolon 1", MEV) is situated near the sea-level, the other ("Megalo Emvolon 2", MEM) 20 m higher and the last one ("Megalo Emvolon 3", MEL) 10 m above the second (KOUFOS et al., 1991).

The deposits of Megalo Emvolon belong to Gonia Formation (SYRIDES, 1990). They consist from bottom to top by: **a.** sand-silts with fossils (MEV), **b.** cross-bedded sands with intercalations of sandstones, **c.** red-beds with intercalated sandstones, calcitic concretions in the upper levels and fossils in the bottom (MEM), **d.** sand-silts with calcitic concretions and fossils (MEL), and **e.** sands and gravels in the top (Fig. 1b). The material collected from each locality is few and the following fauna has been determined: MEV. *Dolichopithecus ruscinensis*, lagomorphs; MEM. *Gazella* sp., bovid ind; MEL. *Sus* cf. *minor*, *Nyctereutes* sp., bovid ind. (KOUFOS *et al.*, 1991). The studied material of lagomorphs was found in the lower fossiliferous locality (MEV) and it will be described and compared in this article.

PALAEONTOLOGY

Order: Lagomorpha BRANDT, 1855.

Family: Leporidae GRAY, 1821

Genus: *Trischizolagus* RADULESCO & SAMSON, 1967.

Trischizolagus dumitrescuae RADULESCO & SAMSON, 1967.

Locality: "Megalo Emvolon 1", MEV, Macedonia, Greece.

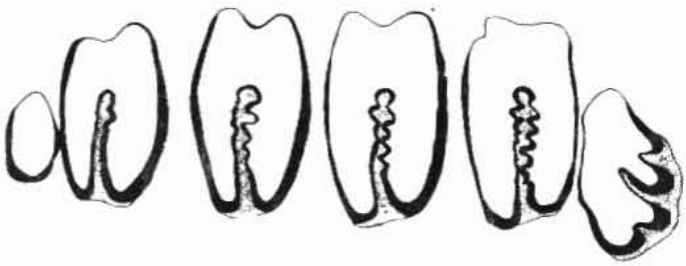


Fig. 2. Trischizolagus dumitrescuae, *Megalo Emvolon*, MEV, Macedonia, Greece. *Right upper toothrow*, MEV 1001.

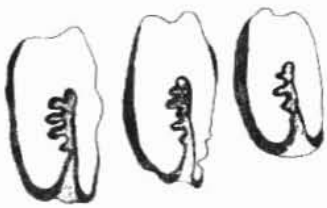
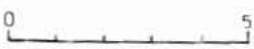


Fig. 3. Trischizolagus cf. maritsae, *Megalo Emvolon*, MEV, Macedonia, Greece. *Left upper toothrow*, MEV 1005.

Fig. 4. Trischizolagus dumitrescuae, *Megalo Emvolon*, MEV, Macedonia, Greece. *Left lower toothrow*, MEV 1003.



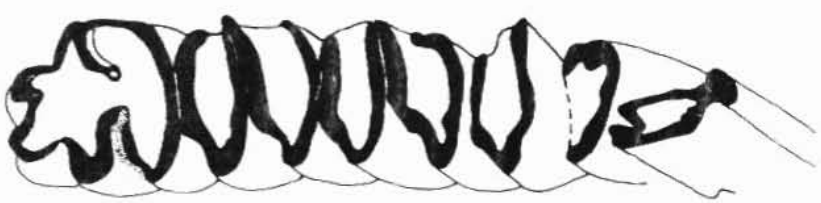


Fig. 5. Trischizolagus dumitrescuae, *Megalo Emvolon*, MEV, Macedonia, Greece. *Left lower toothrow*, MEV 1002.

Material: Left maxillary fragment with P^4-M^2, MEV 1005.

Description: The studied specimen (Fig. 3) preserves only molariform teeth, which are morphologically similar to those of the other studied maxilla. Nevertheless their dimensions are clearly smaller (Tab. I).

DISCUSSION

The late Miocene-Pliocene leporids have been distinguished into two groups according to the enamel crenulation of P_3 (RADULESCO & SAMSON,1967).The first group has simple enamel in P_3 and includes the species *Alilepus annectens* (SCHLOSSER, 1924), *A. laskarewi* (KHOMENKO, 1914), *A."ucrainicus"* CUREEV, 1964, *Trischizolagus dumitrescuae* RADULESCO & SAMSON, 1967, *Serengetilagus praecapensis* DIETRICH, 1942, *"Caprolagus" brachypus* YOUNG, 1927. The second group with crenulated enamel in P_3 includes the species *Veterilepus hungaricus* (KORMOS,1935), *Pliopentalagus dietrichi* (FEJFAR, 1961), *Pratilepus kansasensis* HIBBARD, 1939 and *Nekrolagus progressus* (HIBBARD, 1939). The genus *Trischizolagus* was erected by RADULESCO & SAMSON (1967) with the type species *T. dumitrescuae*. The type material comes from the late Pliocene locality of Malusteni (Romania); it is also found in the locality of Beresti (RADULESCO & SAMSON, 1967). The genus is characterized by the presence of three folds in the trigonid of P_3 with simple enamel at their borders. These features are clear in the studied material (Fig. 4). The type species *T. dumitrescuae* has large size, tetralobed trigonid in P_3, well developed hypoflexid, which reaches about the middle of P_3 breadth, developed mesoflexid, which is transformed into an enamel islet in the worn teeth and elongated trigonid (its length is double than the length of the talonid).

The tetralobe form of the trigonid, the well developed hypoflexid and mesoflexid and the double length of trigonid versus talonid in P_3 of the studied material indicate great similarities with *T. dumitrescuae*. Especially the mesoflexid in the MEV sample represents a transitional stage between a fold and an islet, a feature which characterizes the last species. The metrical comparison of the studied lower teeth with those from Malusteni and Beresti (Romania) indicates that MEV material is very close to the Romanian specimens (Fig. 6) and must belong to *T. dumitrescuae*.

Besides of the type species *T. dumitrescuae*, there is another one named *T. maritsae*. It was found in the early Pliocene locality of Maritsa (Rhodes, Greece) (DE BRUIJN *et al.*, 1970). It is smaller than the type species with a variability in the presence or absence of P_3 mesoflexid. If the mesoflexid is present it is transversally shorter than that of *T. dumitrescuae* or forms a small islet in the worn teeth. The studied lower cheek teeth are clearly larger than those of Maritsa (Fig. 6) with large mesoflexid and thus well distinguished from this species. Two P^2, an unworn and a very worn are known from Maritsa (DE BRUIJN *et al.*, 1970, pl. 10, figs 2,3). In the unworn P^2 there are two anterior folds while in the very worn one there is only

Age: Pliocene, late Ruscinian, MN 15.

Material: Left and right maxillary fragments with P^2-M^3, MEV 1001; left mandibular fragment with P_4-M_2, MEV 1002, left mandibular fragment with P_3 M_3, MEV 1003, left lower incisor, MEV 1004.

Description: The studied material constists of two maxillary fragments with all cheek teeth, parts of the zygomatic arches and a part of the palate, MEV 1001. The mandibular fragment, MEV 1002, fits well with the maxilla, MEV 1001 and both possibly belong to the same individual. The other mandibular fragment, MEV 1003, preserves the horizontal ramus and all the cheek teeth, as well as the root of the incisor. The mandibular corpus is high below the cheek teeth (13,8 mm below M_1) but smaller at the diastema (8,8 mm at the level of mental foramen). The symphysis is elongated and narrow, following the incisor which is directed externally. There is a large mental foramen situated in front of P_3 and some smaller mental foramens in the area of the mandibular corpus below P_3 and P_4. The incisor of MEV 1003 is broken but there is another lower incisor, MEV 1004, which has a trapezoid section; its anteroposterior diameter is 2,5 mm and the tranverse one is 3,2 mm. The nomenclature used for the description of the cheek teeth is that proposed by LOPEZ-MARTINEZ & THALER (1975).

P^2. The mesoflexus and hypoflexus are enough developed while the paraflexus is larger and reaches about halfway across P^2 (Fig. 2). The enamel in the walls of the mesial folds is not crenulated. Most of the mesial and internal part of the tooth is covered by cement.

P_3. The hypoflexid is deep and quite wide (Fig. 4). The mesoflexid is closed lingually but it keeps the character of a fold. The hypoflexid and mesoflexid divide the tooth into two parts, trigonid and talonid. The trigonid length is double than that of the talonid. The hypoflexid reaches the middle of the tooth's breadth. The three folds of the trigonid (protoflexid, anteroflexid, paraflexid) have simple enamel borders (not crenulated). All these folds are continuing until the base of the crown. The distal wall of the tooth is rather straight.

The upper molariform teeth (Fig. 2) have a deep lingual fold, which divides them into two unequal lobes. This fold is covered by cement and extended until the base of the crown. The internal enamel wall of the molariform teeth is crenulated. The third molar is small relatively to the others and oval-shaped. The lower molariform teeth (Fig. 4) are divided into two lobes by a buccal fold with simple enamel walls. The internal area of this fold is covered by cement.

Trischizolagus cf. *maritsae* DE BRUIJN, 1970

Locality: "Megalo Emvolon 1", MEV, Macedonia, Greece.

Age: Pliocene, late Ruscinian, MN 15.

one. In the studied maxilla from MEV both P^2 have three anterior folds and in this feature they differ from Maritsa specimens. May be this difference is due to the different stages of wear. On the other hand there is also a size difference between Maritsa and MEV P^2. The dimensions of P^2 from Maritsa are clearly shorter than those of MEV (Tab. I). The larger size of MEV P^2 also distinguishes the studied maxilla from *T. maritsae*, indicating more similarities with the large-sized *T. dumitrescuae*.

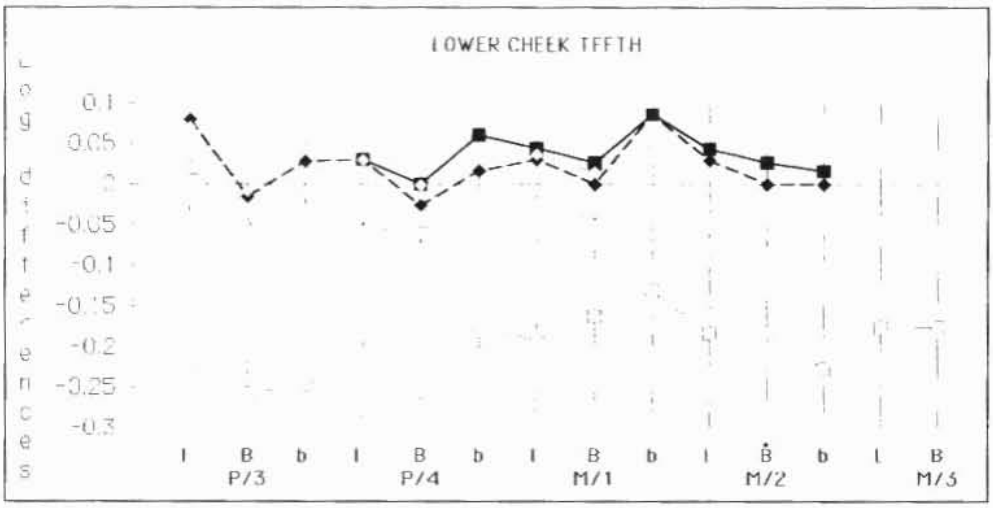


Fig. 6. Logarithmic ratio diagram comparing the lower cheek teeth of Trischizolagus.
***L**= length, **B**= trigonid breadth, **b**= talonid breadth.*
■ Trischizolagus dumitrescuae, *MEV 1002.*
◆ Trischizolagus dumitrescuae, *MEV 1003.*
◇ Trischizolagus dumitrescuae, *Malusteni, Romania.*
△ Trischizolagus dumitrescuae, *Beresti, Romania.*
× Trischizolagus crusafonti, *La Alberca, Spain.*
□ Trischizolagus maritsae, *Maritsa, Rhodes, Greece.*
Standard= Lepus europeaus, *recent.*

Another leporid is known from the late Turolian locality of Alberca (Spain), which was described under the name *Hispanolagus crusafonti* JANVIER & MONTENAT, 1970 and later it was transferred to *Trischizolagus* by LOPEZ MARTINEZ (1977). The Alberca material is badly preserved and the illustrations of JANVIER & MONTENAT (1970) have some differences from the material. The comparison with MEV material was based to some new illustrations given us by Dr. S. Sen. The Alberca leporid has smaller dimensions than *T. dumitrescuae* from Romania and MEV (Fig. 6). A weak mesoflexid is also observed in both P_3 of Alberca (SEN, 1983) and in this feature differs from MEV in which there is a long mesoflexid. The enamel in the posterior wall of the hypoflexid is straight in P_3 of MEV, while it has a fold in the Alberca sample. The

shape of MEV P^2 is more oval, its paraflexus is deeper and its hypoflexus is more developed than in the Alberca material.

Two P^2 from Pul-e Charkhi (Afganistan) was described by SEN (1983) under the name *T.* cf. *maritsae* . They have three anterior folds, which are constant until the base of the tooth. In this feature the Pul-e Charkhi P^2 are similar to the material from MEV. The dimensions are also very close to those from MEV (Tab. I). From the same locality two badly preserved P_3 where described. They are characterized by the deep hypoflexid, the tetralobe trigonid with three anterior folds and by the mesoflexid, which is distinguished in the one (AFG 1015) as an islet. The other P_3 (AFG 759) preserves a small part of the mesoflexid but it is difficult to see its development because of the bad preservation of the tooth. Both P_3 from Pul-e Charkhi are similar to those from MEV in the presence of three anterior reentrants and the deep hypoflexid but they differ in the development of the mesoflexid which is strongly developed in MEV. The one P_3 (AFG 759) from Pul-e Charkhi has also similar dimensions with that of MEV 1003, while the other (AFG 1015) seems to be smaller and closer to Maritsa one (Tab. I).

A mandibular fragment, with P_3-M_1, was described from Altai Mountains, Mongolia (FLYNN & BERNOR, 1987). The material was determined as *Trischizolagus* sp. but its bad preservation makes the comparison with MEV material difficult. The dimensions of P_3 (Tab. I) indicates a large-sized *Trischizolagus* similar to MEV 1003, and to AFG 759 from Pul-e Charkhi, as well as to the material from Romania. Although its morphology without mesoflexid (FLYNN & BERNOR, 1987, fig. 3) is closer to Maritsa and to AFG 1015 from Pul-e Charkhi.

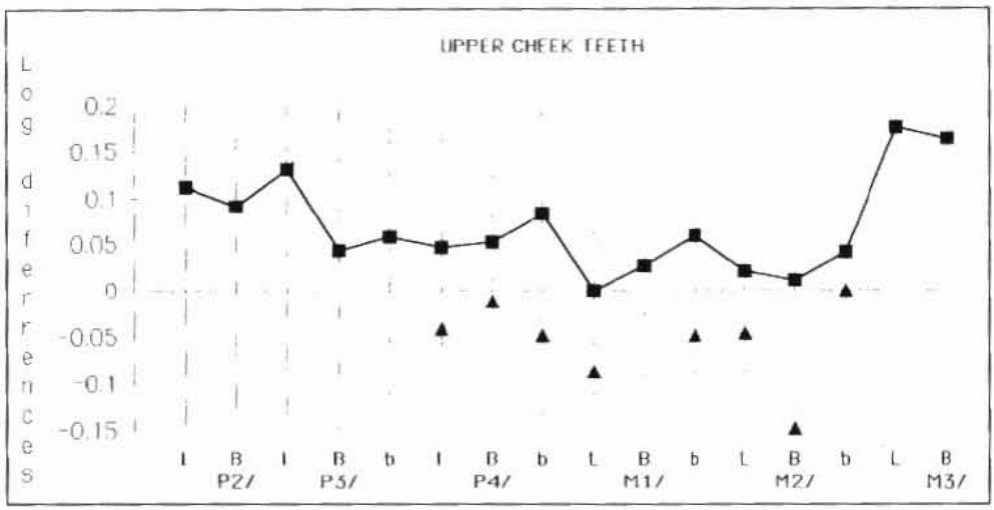


Fig. 7. Logarithmic ratio diagram comparing the upper cheek teeth of Trischizolagus.
■ Trischizolagus dumitrescuae, *MEV 1001.*
▲ Trischizolagus cf. maritsae, *MEV 1005.*
Standard= Lepus europeaus, *recent.*

	MEV 1001		MEV 1005	MEV 1002	MEV 1003	Malusteni			Beresti	Maritsa	Pul-e Charki		Mongolia	La Alberca
	dex	sin	sin	dex	dex	min	mean	max						
L	2.2	2.2								0.8	1.9			1.4
P2/ B	3.8	3.6								1.5	3.5			2.8
L	2.5	2.1								Molariform	Molariform			1.7
P3/ B	4.4	4.0								1.5 1.5	2.1			
b	4.8	4.8								3.1 2.7	4.6			3.2
L	2.5	2.4	2											2.0
P4/ B	4.6	4.2	3.8											
b	4.8	4.4	3.4											3.3
L	2.3	2.1	1.8											1.9
M1/ B	4.3	4.0												
b	4.5	4.2	3.4											3.0
L	2.1	2.1	1.8											1.5
M2/ B	4.0	3.8	2.7											3.0
b	3.4	3.2	3											
L	0.9	0.9												0.9
M3/														1.4
I	1.7	1.8												
L					3.6	3.32	3.52	3.78	3.14	2.20	3.2		3.3	2.8
P/3 B					2.8	2.75	2.84	2.90	2.58	1.92	2.9	1.9	2.84	
b					3.2	3.12	3.32	3.56	2.93	2.12	3.2			2.9
L				3.0	3.0	2.90	3.00	3.07		1.7				2.5
P/4 B				3.4	3.2	3.22	3.39	3.51	3.07	2.1				2.9
b				3.2	2.8	2.77	2.90	2.97		1.8				
L				3.1	3.0	2.97	3.04	3.09		1.8				2.7
M/1 B				3.4	3.2	3.14	3.31	3.46		2.2				2.9
b				2.8	2.8	2.50	2.59	2.63		1.7				
L				3.2	3.1					1.9				2.5
M/2 B				3.4	3.2					2.1				2.7
b				3.8	2.7					1.6				
L										1.2				
M/3 B										1.2				
b										0.9				

TABLE 1. *Cheek teeth of* Trischizolagus *from various localities.* **L**= *length;* **B**= *breadth of the first lobe or of the trigonid;* **b**= *breadth of the second lobe or of the talonid.*

The other studied maxilla, MEV 1005, has only molariform teeth and it is difficult to be determined. In comparison with the maxilla, MEV 1001, the teeth are smaller (Tab. I, Fig. 7). From the small-sized species *T. maritsae* only two upper molariform teeth are known (DE BRUIJN *et al.*, 1970). Their dimensions are close to those of MEV 1005 and clearly smaller than those of MEV 1001 (Tab. I). Thus according to the size MEV 1005 seems to be similar with *T. maritsae* but because of the absence of P^2 it is referred to *T.* cf. *maritsae*.

The above mentioned comparison of the lagomorphs from Megalo Emvolon indicates that there are two different forms one small-sized and another large-sized. The morphological characters and the dimensions of the large-sized form allow us to include it to *T. dumitrescuae*. The small-sized form fits better by its dimensions to *T. maritsae* and it is referred as *Trischizolagus* cf. *maritsae*.

Even after these conclusions from the study of MEV *Trischizolagus* there is still the question if there are two different species of *Trischizolagus* together or only one. The main differences distinguishing *T. maritsae* from *T. dumitrescuae* are the smaller size and the less developed or absent mesoflexid in P3 of the first species (DE BRUIJN *et al.*, 1970). Unfortunately the upper dentition of *T. dumitrescuae* is unknown from the type locality making impossible a comparison with the Maritsa sample. The two distinctive characters of *T. maritsae* are observed together in the other known material of *Trischizolagus*. In the material of Pul-e Charki (SEN, 1983) two forms can be distinguished from the size of P_3. The small-sized P_3 (AFG 1015) has a very small mesoflexid islet and by these characters fits very well with *T. maritsae*. The large-sized P_3 (AFG 759) has similar dimensions with MEV and romanian sample of *Trischizolagus dumitrescuae*; it also preserves a very small mesoflexid islet (SEN pers. comm.) but it is difficult to see the mesoflexid development because of the bad preservation in this area (SEN, 1983, Fig. 83). On the other hand the upper molariform tooth of Pul-e Charki (AFG 770) has similar dimensions with the large-sized form from MEV, which is considered as *T. dumitrescuae*. For all these reasons the material from Pul-e Charkhi is referred under the name *T.* cf. *maritsae* (SEN 1983). The same problem is also existed in the material from Mongolia (FLYNN & BERNOR, 1987). The preservation is very bad and the only known P_3 is very worn. The absence of the mesoflexid is a feature which indicates *T. maritsae* but the large dimensions (Tab. I) indicate a form similar to *T. dumitrescuae*.

In MEV material it is clear that there is a large-sized form with well developed mesoflexid in P_3 but there is also another one with smaller dimensions. Unfortunately the small-sized form is known only by upper molariform teeth, which make impossible a specific determination. Moreover P^2 of the large-sized form from MEV differs from that of *T. maritsae* in the presence of three folds versus one-two in *T. maritsae* but no upper teeth from Romania for comparison.

All the above mentioned and the comparisons of MEV material with the known *Trischizolagus* allow two hypotheses. The first is that there are two different species of

Trischirolagus lived together. A large-sized with well developed mesoflexid in P3 and a small-sized with less developed or absent mesoflexid. They were named *Trischizolagus dumitrescuae* and *Trischizolagus* cf. *maritsae* respectively. The second hypothesis is that the variation in the size and in the development of mesoflexid in P3 must be of intraspecific value and only one species is existed, which must be named *Trischizolagus dumitrescuae* (prior name). The answer to these two suggestions is difficult with the known material. For that reason it is better at the moment to distinguish the MEV material into two forms referred as *T. dumitrescuae* and *T.* cf. *maritsae*, waiting for more material which will give more data about the specific distinction of the genus.

BIOSTRATIGRAPHY

The whole mammalian fauna of Megalo Emvolon determined by the various authors with the addition of the studied lagomorphs is: *Trischizolagus dumitrescuae, Trischizolagus* cf. *maritsae, Oryctolagus* cf. *laynensis, Microspalax odessanus, Dolichopithecus ruscinensis, Nyctereutes* sp., *Hipparion longipes, Sus minor, Parabos makedoniae, "Gazella bailloudi", Testudo* cf. *graeca* and *Testudo* sp. (very large).

The age of Megalo Emvolon deposits has been discussed by the various researchers, who studied some fossils from the area and there is a general agreement that it is Ruscinian. The deposits of Megalo Emvolon belong to Gonia Formation, which has been dated to Ruscinian because: **a.** of a micromammalian fauna, found in the neighbouring area and **b.** of the presence of volcanic pebbles, originating from Almopia volcanos; the last were dated as 5.0-1.8 m.y. with the bulk eruption estimated at 4-5 m.y. (SYRIDES, 1990).

The presence of *Hipparion longipes* in the Megalo Emvolon fauna suggests a Ruscinian age. This species was found in Pavlodar (USSR) with an uncertain age, late Miocene-early Pliocene (GROMOVA, 1952) and later it was found in the certain Ruscinian, MN 15, locality of Calta (Turkey), (SEN et al.,1978). *Microspalax odessanus* of Megalo Emvolon is considered as the earliest appearence of the genus and indicates a late Ruscinian age, MN 15 (DE BRUIJN, 1984). The strong similarities of Megalo Emvolon *Dolichopithecus ruscinensis* with that from Perpignan suggests also a late Ruscinian, MN 15 age for M. Emvolon deposits (KOUFOS et al., 1991). Moreover the presence of Sus minor with *Parabos* indicates also a late Ruscinian, age MN 15 (MEIN, 1979).

The determined lagomorphs of Megalo Emvolon confirm the above mentioned age of the fauna. The romanian localities of Malusteni and Beresti, in which *Trischizolagus dumitrescuae* was found, were considered as early Villafranchian, phase I (RADULESCO & SAMSON, 1967). Recently in the new revision of the MN zones both localities are dated to late Ruscinian and more precisely to MN 15 (MEIN, 1990). The great similarity of the MEV material with the romanian sample suggests a similar age, MN 15 for Megalo Emvolon deposits confirming the

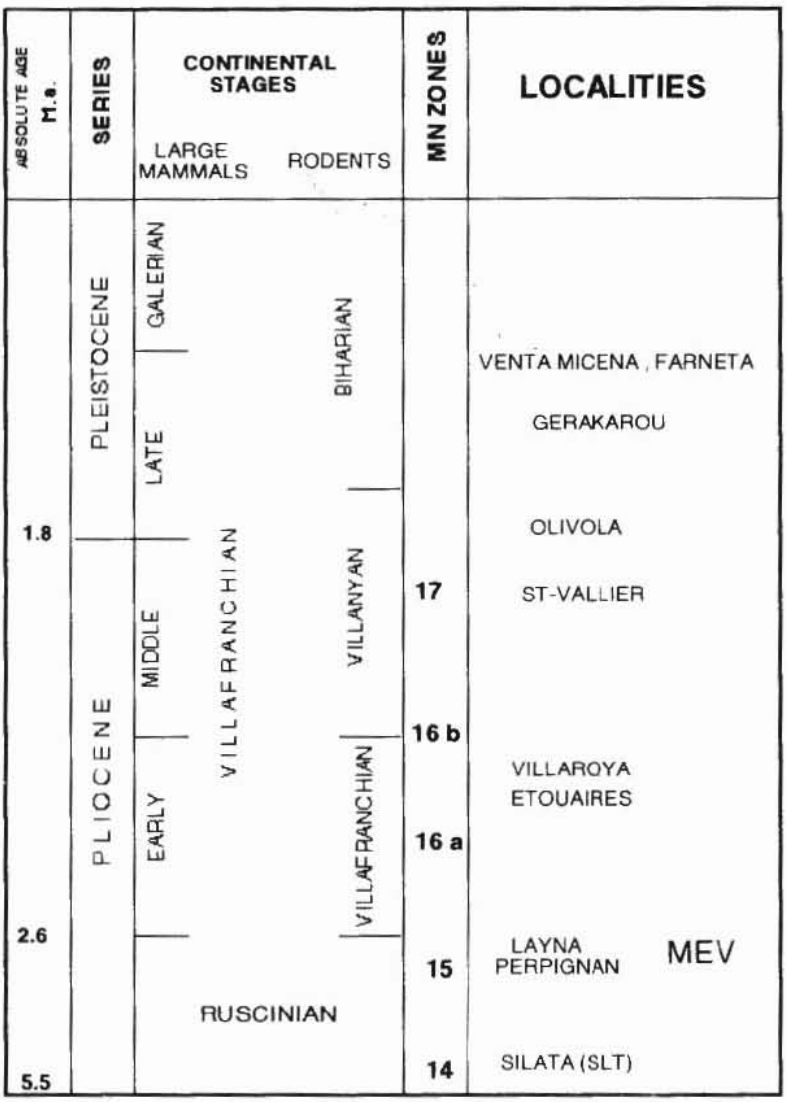


Fig. 8. Table summarizing the chronostratigraphic position of "Megalo Emvolon 1", MEV.

age proposed by the other material (Fig. 8). *T. maritsae* is considered more primitive than the type species and its type locality has been dated to MN 14 (BRUIJN et al., 1970; MEIN, 1990). The other focalities in which it is possibly present, Pul-e Charki (Afganistan) and Altai Mountains (Mongolia) have been dated to early Ruscinian and to the limit between

Miocene/Pliocene respectively (SEN, 1983; FLYNN & BERNOR, 1987). If *T. maritsae* is certainly existed in Megalo Emvolon and more precisely in MEV, which was dated to late Ruscinian, MN 15 by the presence of *Dolichopithecus ruscinensis* (KOUFOS et al., 1991) and *T. dumitrescuae*, then we must suppose that *T. maritsae* is still existed in MN 15, together with the more evolved *T. dumitrescuae*.

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