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A NEW PLEISTOCENE MAMMAL LOCALITY FROM MACEDONIA (GREECE). CONTRIBUTION TO THE STUDY OF VILLAFRANCIAN (VILLANGIAN) IN CENTRAL MACEDONIA

G. KOUFOS, G. SYRIDES, K. KOLIADIMOU

A B S T R A C T

A new Pleistocene mammal locality (RVL) was found in Marathousa basin (basin of the lakes Langada-Volvi). The stratigraphic position, age and the relations of it with the other known localities of the area, are studied. A revision of the presence and the characters of the Villafranchian in C.Macedonia is also given. The determined species *Canis arnensis*, *Equus stenonis*, *Hippopotamus major* indicate a Latest Villafranchian - Early Biharian age for the new locality. The fosiliferous deposits reveal a fluviolacustrine environment and they represent a new formation (Platanochori Formation).

Σ Υ Ν Ο Ψ Η

Η εργασία αυτή αναφέρεται σε μια νέα απολιθωματοφόρα θέση θηλαστικών (RVL) στη λεκάνη της Μαραθούσας (λεκάνη λιμνών Λαγκαδά-Βόλβης). Μελετώνται η πανίδα, προσδιορίζεται η ηλικία και η στρωματογραφική θέση των αποθέσεων και γίνεται συγκριση με άλλες απολιθωματοφόρες θέσεις της περιοχής. Επιχειρείται επίσης, μια σύνοψη για την παρουσία και τους χαρακτήρες του Βιλλαφραγκίου στη λεκάνη της Μυγδονίας. Τα προσδιορισθέντα είδη *Canis arnensis*, *Equus stenonis*, *Hippopotamus major*, δείχνουν ηλικία Ανώτατου Βιλλαφράγκιου - Κατώτερου Μπιχάριου. Τα ιζήματα τα οποία περικλείουν την απολιθωμένη πανίδα είναι ποταμολιμναίας φάσης και αντιπροσωπεύουν ένα νέο σχηματισμό (Σχηματισμός Πλατανοχωρίου).

1. INTRODUCTION

Geological field work in the basin of Mygdonia (Lake Langada - Lake Volvi area) and in the surrounding small basins and grabens (Zagliveri, Marathousa, Daubia) during last years reveal several mammalian localities as those of Krimni, KRI (SAKELLARIOU et al., 1979) and Gerakarou, GER (ZAMANIS et al., 1980; KOUFOS & MELENTIS, 1983). Several new sites with mammals have been found last year but only one yielded a sufficient number of well preserved fossils. In this article we shall try to determine and compare the first collected material, to date the fauna and the sedimentary deposits, to correlate it with the other Villafranchian localities of Mygdonia basin and to revise the available data for the Villafranchian of C.Macedonia.

Marathousa basin is situated about 40 Km East of Thessaloniki. It is bordered by Stratonikon Mt to the East, Cholomon Mt. to the South and communicates with Mygdonia basin to the North. A hilly terrain is the western boundary between Ma-

Γ.Δ.ΚΟΥΦΟΣ, Γ.Ε.ΣΥΡΙΔΗΣ και Κ.ΚΟΛΙΑΔΗΜΟΥ - Νέα απολιθωματοφόρα θέση θηλαστικών του Πλειστόκαινου από τη Μακεδονία (Ελλάδα). Συμβολή στη μελέτη του Βιλλαφράγκιου στην κεντρική Μακεδονία.

Aristotelian University of Thessaloniki. Department of Geography and Physical Geography, P.Box. 351-1, 54006 THESSALONIKI, Greece.

rathousa and Zagliveri basin. Two big torrents Megalo Rema and Cholomon Rema drain the basin towards Lake Volvi forming large deltas.

The basin was formed into the Serbomacedonian massif (Mesozoic granite of Arnea), while to the S.W. rocks of the Circum Rhodope belt (Mesozoic phyllites, limestones and volcanosedimentary rocks) were occured (KOCKEL-MOLLAT 1977, KAUFFMANN-KOCKEL-MOLLAT, 1976).

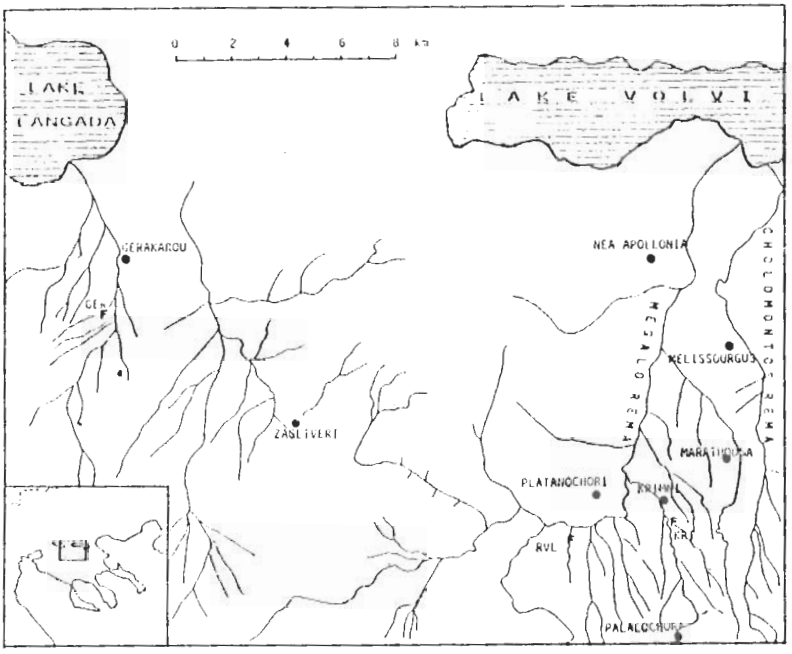


Fig. 1.: Sketch map of Mygdonia basin with the mammalian localities.

Σχ. 1.: Χάρτης της λεκάνης της Μυγδονίας με τις απολιθωματοφόρες Θέσεις Θηλαστικών.

According PSILOVIKOS (1977), PSILOVIKOS-SOTIRIADIS (1983) Marathousa basin was part of an older, bigger and wider expanded basin, the Promygdonia basin, which was formed by tectonic action probably during Late Palaeogene-Early Neogene. Fluvial, lacustrine, terrestrial, fluvioterrestrial sediments (Promygdonian group) were deposited into this basin, during Late Miocene to Villafranchian (Fig. 2). During Early Pleistocene a new phase of tectonic action faulted the Promygdonia basin and some younger and smaller basins and grabens were formed. (Mygdonia, Vromolimnes, Zagliveri, Marathousa, Doubia). Water filled up the subsided Mygdonia basin forming the Lake of Mygdonia. Lacustrine sediments were deposited in this lake (Mygdonian group), (Fig. 2). The Mygdonia lake during Middle - Late Pleistocene was drained up gradually and the present lakes of Langada

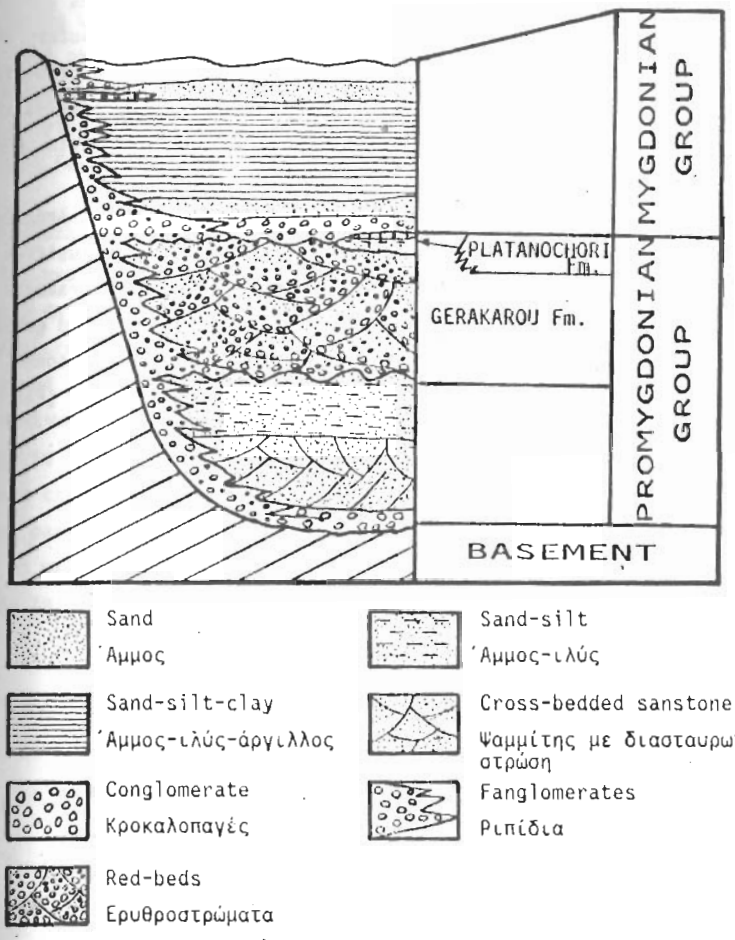


Fig. 2.: Synoptic stratigraphic section of Mygdonia basin (data from PSILOVIKOS, 1977, PSILOVIKOS & SOTIRIADIS, 1983).

Σχ. 2.: Συνοπτική στρωματογραφική τομή της λεκάνης της Μυνδονίας (στοιχεία από ΨΙΛΟΒΙΚΟΣ, 1977; PSILOVIKOS & SOTIRIADIS, 1983)

and Volvi are the remnants of the initial one.

The northern part of Marathousa basin was occupied by the Mygdonian group (lacustrine sediments of Melissourgos), while the central and southern parts of the basin kept their terrestrial character. Several intensive erosional phases have eroded the whole area forming a complicate drainage pattern with deep incised valleys, step slopes and river terraces.

2. LOCALITY

The new locality is situated in the western part of Marathousa basin in the

vicinity of Platanochori village (Fig. 1). The site is located about 1,5 Km SW of Platanochori in the west slope of a South to North trending tributary ravin of Megalo Rema. The locality was found during an excavation in the property of Mr. Voulgarakis, who reported to the authors the presence of the fossils and for this reason we gave the name "Ravin of Voulgarakis" (RVL) to the ravin and the new locality.

The red-beds (Grakarou Formation) and the basement (granite of Arnea) outcrops in the surrounding area of the locality. Fluviolacustrine-lacustrine sediments, about 10 m thick, were deposited on the upper part of the Gerakarou Formation. These deposits consist from below to upwards of coarse sand and gravel, green-grey clayey-silty sand, marls and grey-white fresh-water limestones, with massive bedding. The fossils were found in the clayey-silty sand bed (Fig. 3).

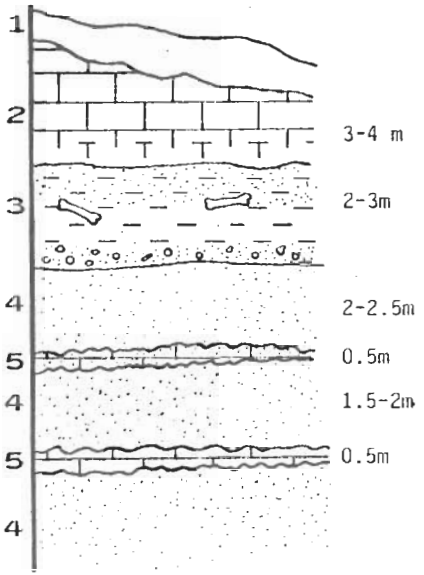


Fig. 3.: Geological section of the mammalian locality "Ravin of Voulgarakis" (RVL)

Σχ. 3.: Γεωλογική τομή της απολιθωματοφόρας θέσης Θηλαστικών RVL.

1. Soil - Έδαφος.
2. Massive tuffaceous limestone with ovoids, desication crucks and root-traces; its lower part consits of nodular clayey marl.
   Μαζώδεις-τοφφώδεις ασβεστόλιθοι με κοιλότητες, ρωγμές ξήρανσης και ίχνη ριζών· η βάση του αποτελείται από αργιλλούχο κονδυλώδη μάργα.
3. Green-grey silty clay with a lot of sand and gravels at the base.
   Γκριζοπράσινη ιλύς-άργιλλος πλούσια σε άμμο και κροκάλες στη βάση της.
4. Red-brown fine-medium grained sand with fine bedding; it represents the uppermost parts of the Gerakarou Formation (red-beds).
   Καστανέρυθρη λεπτο-μεσόκοκκη άμμος με λεπτή στρώση· αντιπροσωπεύει τα τελευταία στρώματα του Σχηματισμού της Γερακαρούς (ερυθροστρώματα).
5. Nodular calcareous sandstone.
   Ασβεστοψαμμιτικά στρώματα με κονδυλώδη επιφάνεια.

Between the red-beds and these fluviolacustrine-lacustrine sediments, a few alternating beds of grey-white nodular, sandy marl, and well bedded fine red sands were observed. These alternating beds correspond to a transitional zone from a terrestrial (red-beds) to a gradually lacustrine environment. These fluviolacustrine-lacustrine deposits represent a new formation, which is named Platanochori Formation.

3. PALEONTOLOGY

The available material from RVL allow us to determine this and to give a preliminary dating of the locality. The RVL fauna contains some macromammals and a lot of micromammals. In this article the available material will be shortly described and compared with others.

Carnivora: A well preserved M^1 (RVL-1) of a canid it is the only known from RVL. It is unworn with developed paracone, metacone and protocone. The last forms a convex crest and it is curved posteriorly. Two small cusps are situated one between paracone and protocone and the other between metacone and protocone. There is well developed buccal, mesial and distal cingulum. RVL-1 morphologically belongs to a canid and its metrical comparison with some Pleistocene species of

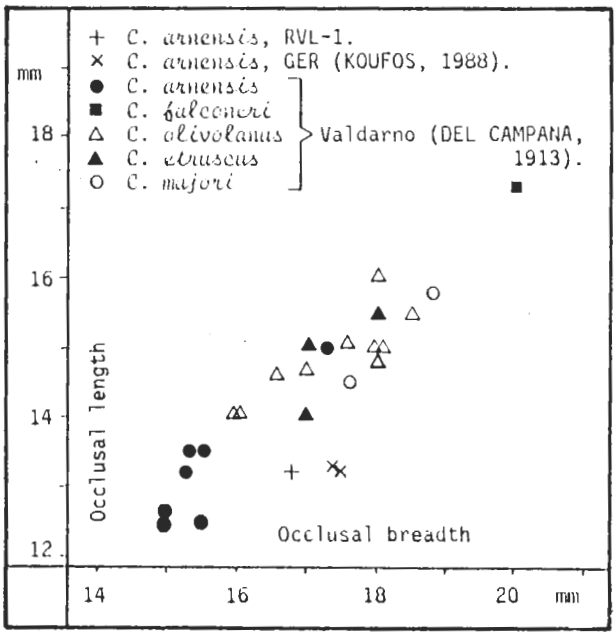
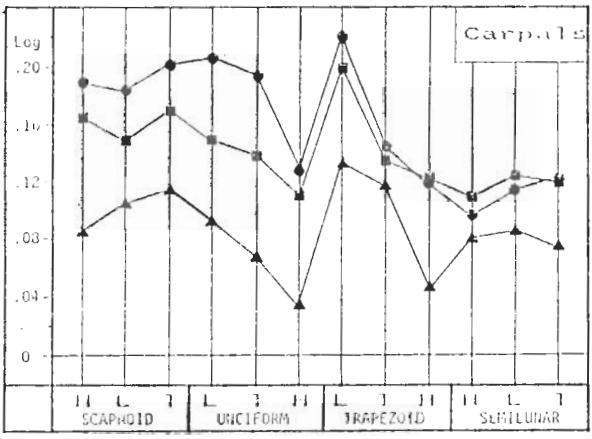
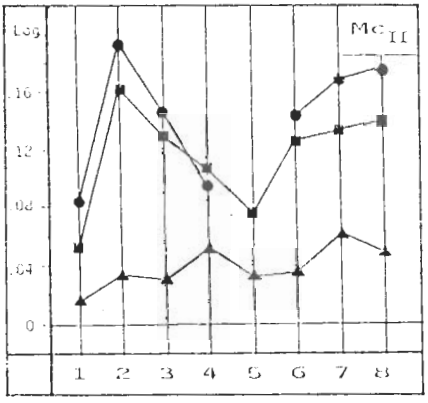


Fig.4.: Scatter diagram occlusal breadth/occlusal length for M^1 of various Pleistocene canids.

Σχ. 4.: Συγκριτικό διάγραμμα πλάτους/μήκους της μασητικής επιφάνειας του M^1 σε διάφορα Πλειστοκαινικά Canidae.





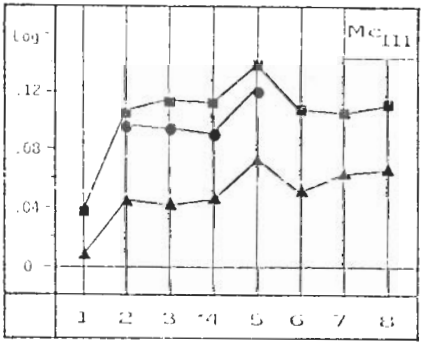
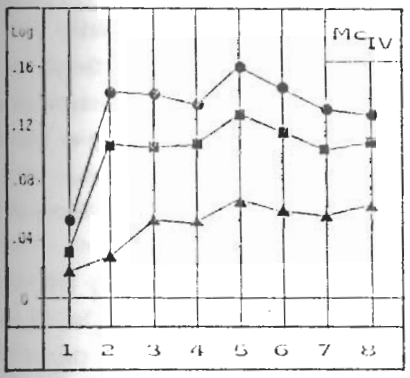
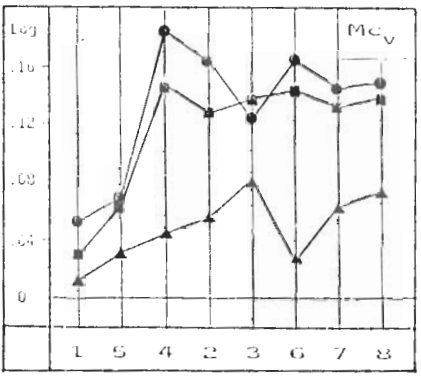


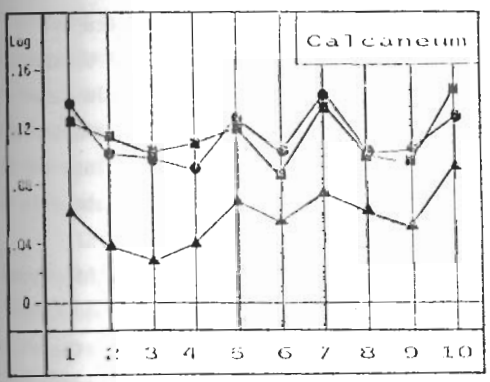
Fig.5.: Ratio diagram comparing the carpals, Mc_{II} and Mc_{III} of the RVL hippopotamid with those of *H. major* and *H. incognitus*.
Carpals: L=anteroposterior diameter, I=transverse diameter, H=height.
Metapodials: 1.Height, 2.$DT_{prox.}$, 3.$DAP_{prox.}$, 4.$DT_{diaph.}$, 5.$DAP_{diaph.}$, 6.$DT_{max.dist.}$, 7.$DT_{art.dist.}$, 8.$DAP_{dist.}$.

Σχ. 5.: Λογαριθμικό διάγραμμα σύγκρισης των καρπικών, Mc_{II} και Mc_{III} του ιπποποτάμου από το RVL με εκείνα του *H. major* και *H. incognitus*.
Καρπικά: L=εμπροσθοπίσθια διάμετρος, I=εγκάρσια διάμετρος, H=ύψος.
Μεταπόδια: 1.Ύψος, 2.Πλάτος άνω άκρου, 3.Μήκος άνω άκρου, 4.Πλάτος διάφυσης, 5.Μήκος διάφυσης, 6.Μέγιστο πλάτος κάτω άκρου, 7.Πλάτος κάτω αρθρωτικής επιφάνειας, 8.Μήκος κάτω άκρου.

Standard *H. amphibius* ■ *H. major* ▲ *H. incognitus* } FAURE (1985)
● *H. major*, RVL







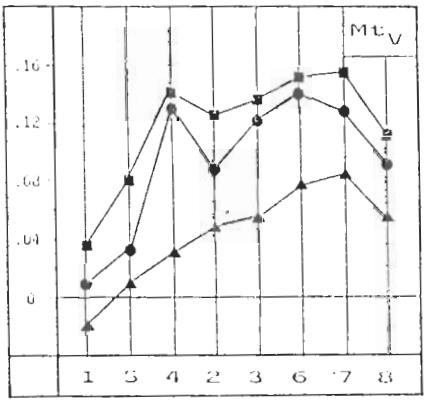


Fig.6.: Ratio diagram comparing, Mc_{IV}, Mc_V, calcaneum and Mt_V of the RVL hippopotamid with those of *H. major* and *H. sivalensis*; abbreviations and measurements as in Fig. 5.

Calcaneum: 1. Height, 2. DT_{tuber}, 3. DAP_{tuber}, 4. $DT_{post.border}$, 5. $DT_{sustentaculum}$, 6. DAP_{beak}, 7. $H_{sustentaculum}$, 8. $DAP_{above\ beak}$, 9. $DAP_{artic.sustentaculum}$, 10. $DAP_{anterodistal\ bord}$.

Σχ. 6.: Λογαριθμικό διάγραμμα σύγκρισης των Mc_{IV}, Mc_V, πτέρνας και Mt_V του ιπποποτάμου από το RVL με εκείνα του *H. major* και *H. sivalensis*; συντμήσεις και μετρήσεις όπως στο Σχ. 5.

Πτέρνα: 1. Ύψος, 2. Πλάτος του tuber, 3. Μήκος του tuber, 4. Πλάτος στην πίσω πλευρά, 5. Πλάτος του sustentaculum, 6. Μήκος του ράμφους, 7. Ύψος του sustentaculum, 8. Μήκος πάνω από το ράμφος, 9. Μήκος της αρθρωτικής επιφάνειας του sustentaculum, 10. Μήκος της εμπρόσθιας - κάτω πλευράς.

Canis indicates a similarity with *C. arnensis* (Fig. 4). RVL-1 is situated near to the material from Valdarno (Italy) and it is very close to that from Gerakarou (GER). Both M^1 from GER belong to a complete skull, which has been determined to *C. arnensis* (KOUFOS, 1987). This morphological and metrical similarity of RVL-1 with the teeth of the skull from GER, allow us to suppose that it belongs to *C. arnensis*. Although RVL-1 and GER teeth seem to be somewhat wider than those of Valdarno.

Perissodactyla: A piece of the right mandibular ramus with P_3-P_4 (RVL-4) and an isolated $dp^{3,4}$ (RVL-3) are only found. The studied lower premolars belong to the "stenonine type" (EISENMANN, 1981, p. 136), as indicated by the V-shaped linguaflexid, the convex lingual borders of metaconid and metastylid the fairly developed parastylid (it reaches to the middle of the tooth's breadth) and the very obliquely situated preflexid. This morphology of the studied teeth allow us to suppose that they belong to *E. stenonis*. Several subspecies of *E. stenonis* are known (GROMOVA, 1949; PRAT, 1968; GIULLI, 1972; EISENMANN, 1981). A subspecific determination of the RVL equid is very difficult with the available material. Although the RVL equid seems to be similar with that from GER. The material from GER is very rich, but still unpublished, and it seems to be very close to the Senèze horse (*E. stenonis senezensis*). Although the GER equid has some differences from the Senèze one.

Artiodactyla: The artiodactyls are represented in RVL by a lot of hippopotamid bones (metapodials, carpals, tarsals) and some isolated teeth. The morphology of the bones among the various species of *Hippopotamus* is similar but their size is different and can distinguish these. FAURE (1985) refers two large-sized species, *H. major* and *H. incognitus*, in the Pleistocene of Europe. The RVL material in comparison with the mean values for these two species (Fig. 5, 6), is similar to *H. major*. Some size differences are possibly due to the small number of specimens from RVL, but in any case the measurements of the RVL material are into the ranges of variation for *H. major*. Thus RVL material must belong to *H. major*.

Micromammals: The micromammals are a lot and after the cleaning of enough material we found a lot of lagomorphs and some rodents. The collection of the material will be continued and it will be studied later. A lot of fish-otolites, were also found.

4. AGE OF THE FAUNA

The RVL fauna and its relations with those of the known localities of Mygdonia basin and Europe allow us to suppose the age of the locality. *E. stenonis* is a characteristic representative of the Late Villafranchian and indicates the begining of Pleistocene. Its presence in RVL is an evidence for the Pleistocene age of the fauna and locality. Nevertheless the similarity of the RVL and GER equid,

and that of the GER and Senèze equid, allow us to consider a Late Villafranchian age for the RVL.

C. arnensis is a Late Villafranchian species known from Upper Valdarno (Italy); more presicely it indicates the end of Villafranchian (AZZAROLI, 1967). The presence of this species in GER, which is dated back to Late Villafranchian by a rich fauna (KOUFOS, 1986a, 1986b, 1987; KOUFOS & MELENTIS, 1983), and its similarity with the RVL material give us an idea about the age of the RVL fauna. According to the above mentioned data about *C. arnensis*, the RVL can be dated to the end of Villafranchian.

This age is also confirmed by the presence of *H. major*. This species is known from the Upper Valdarno and indicates the end of the Villafranchian (AZZAROLI, 1967). A similar age, end of Villafranchian-beggining of Biharian, is also referred in Europe for *H. major* by FAURE (1985). He refers that *H. major* is certainly present in the zones MNQ-20, 21 (Biharian) and then dissappeared, while *H. incognitus* appeared at the end of the zone MNQ-20 and it is present in the rest of Pleistocene. According to this interpretation the RVL age cannot be younger than the zone MNQ-21 and thus a Villafranchian-Biharian age is possible. Unfortunately there are not hippopotamids in the neighboring localities of Gerakarou and Krimni for comparison.

All the above mentioned faunal data and their interpretation, as well as, some stratigraphical evidences can help us to suppose an age about the Platanochori Formation. The presence of *E. stenonis* indicates a Late Villafranchian (Pleistocene) age, while *C. arnensis* and *H. major* indicate the end of Villafranchian-beggining of Biharian. The Platanochori Formation, overlies the Gerakarou Formation which contains the localities of Gerakarou (GER) and Krimni (KRI) and has been dated to Late Villafranchian (KOUFOS & MELENTIS, 1983). After that a slightly younger age (Latest Villafranchian - Early Biharian) is possible for the Platanochori Formation. In Fig. 7 the age and the correlation of the mammalian localities GER, KRI and RVL with the known greek and european ones are given.

5. THE VILLAFRANCHIAN IN CENTRAL MACEDONIA

The Villafranchian (Villanyian) stage is known in Macedonia by enough localities, as those of the Grevena basin (BRUNN, 1956), of the Ptolemais-Florina basin and of the Drama basin (locality of Volax) (SICKENBERG, 1968). In central Macedonia and especially in Mygdonia basin the localities of Gerakarou (GER) and Krimni (KRI) are well known. These localities (GER, KRI) occur into the Gerakarou formation. The studied locality (RVL) belongs to the Platanochori Formation, that overlies the Gerakarou Formation (Fig. 2). The following species have been determined from these localities.

K r i m n i (KRI): *Equus stenonis*, *Dicerorhinus etruscus* (SAKELLARIOU et al.,

AGE Ma	SERIES	CONTINENTAL STAGES		CORRESPONDING MAMMALIAN LOCALITIES	
			MN ZONES	GREECE	EUROPE
	PLEISTOCENE	BIHARIAN		Megalopolis	Mosbach upper Forest bed
		VILLAFRANCHIAN (VILLANYIAN)	20	Ravin Voulgarakis	Mosbach lower
			19	Krimni, Gerakarou	Upper Valdarno, Senèze
			18		St Vallier, Roccaneyra
1.8			17	Kos	
	PLIOCENE			Rhodos	Etouaires, Montopoli
3.2			16		
		RUSCINIAN	15	Ptolemais, PTL	Perpignan Layna
				Megalo Emvolon	
			14	Ptolemais-1,3	Montpellier
5.0				Kardia	

Fig. 7.: Table summarizing the stratigraphic position of RVL and correlating it with other mammalian localities (data from BENDA & MEULENKAMP, 1979; FAURE, 1985).

Σχ. 7.: Πίνακας με τη στρωματογραφική θέση της θέσης RVL και συσχέτισή της με άλλες απολιθωματοφόρες θέσεις θηλαστικών (κατά BENDA & MEULENKAMP, 1979; FAURE, 1985).

1979).

G e r a k a r o u (GER): *Canis arnensis, Equus stenonis* cf. *senezensis, Sus strozzi, Croizetoceros ramosus* cf. *minor, Eucladoceros senezensis senezensis, Cervus* cf. *philisi, Gazella borbonica, Gazellospira* sp. (KOUFOS, 1986a,b, 1988; KOUFOS & MELENTIS, 1983).

R a v i n o f V o u l g a r a k i s (RVL): *Canis arnensis, Equus stenonis, Hippopotamus major*, Lagomorpha, Rodentia.

The Gerakarou Formation outcrops in the area between the villages Gerakarou, Zagliveri, Palaeochora and Marathousa. It consists of red-beds with cross-bedded silt-clay, sand and gravels. The upper parts of the formation occur as loose sand (Fig. 2), bed 4). The Gerakarou Formation is of a fluvioterrestrial origin and was deposited during a period of a strong erosion and warm climate with wet and dry epochs. The fauna found in the localities KRI and GER indicates a Late Villafranchian age for the upper parts of the Gerakarou Formation (SAKELLARIOU et al.,1979; KOUFOS & MELENTIS, 1983). Thus the Gerakarou Formation must be deposited during

Villafranchian.

The Platanochori Formation outcrops near the village of Platanochori (Ravin of Voulgarakis) and possibly in some other sites of the area. It consists of fluviolacustrine clayey-silty sediments and limestones. It was deposited in a different environment than that of the Gerakarou Formation. It seems that at the end of Villafranchian small lakes were formed in the area. The RVL belongs to one of this lakes and in the geological section (Fig. 3) the transition from the Gerakarou Formation to the Platanochori one is clear (alternated red sands and lacustrine limestones, beds 4,5). The presence of the lake is confirmed by the hippopotamids, which lived near it and the numerous fish-otolites found in the sediments. Around these lakes a lot of animals were lived (hippopotamids, lagomorphs, rodents) or came to find water or food (carnivors). The fauna of the RVL indicates a Latest Villafranchian-Early Biharian age for the Platanochori Formation. This interpretation of the Villafranchian in the Mygdonia basin shows that this stage is represented in the area by two formations a) the fluvioterrestrial Gerakarou Formation, which consists of red-beds, dated to Late Villafranchian at least and b) the new fluviolacustrine Platanochori Formation, which consists of clayey, silty and calcareous sediments, dated to Latest Villafranchian - Early Biharian.

REFERENCES

AZZAROLI, A. 1967: Villafranchian correlations based on large mammals. Comm.Med. Neog.Str., Proc. IV Session, Bologna 1967, Giorn. di Geol., (2) XXXV, fasc. 1, 1-21.

BENDA, L. & MEULENKAMP, J.E. 1979: Biostratigraphic correlations in the eastern mediterranean Neogene. 5. Calibration of sporomorph associations, marine microfossil and mammal zones, marine and continental stages and the radiometric scale. Proc. VIIth Int. Cong. Medit. Neog. Ann. Géol. Pays Hell. Hors ser. I: 61-70.

BRUNN, J. 1956: Contribution a l' etude geologique du Pinde septentrional et d' une partie de la Macédoine occidentale. Ann.Géol.Pays Hell. 7, 1-358.

DEL CAMPANA, D. 1913: I cani Pliocenici di Toscana. Palaent.Ital.,XIX,189-254, 10 pls.

EISENMANN, V. 1981: Étude des dents jugales inférieures des *Equus* (Mammalia. Perissodactyla) actuels et fossilles. Palaeovertebrata. 10, Fasc.3-4, 1-226, 4 pl.

FAURE, M. 1985: Les hippopotames quaternaires non-insulaires d' Europe occidentale. Nouv.Arch.Mus.Hist.nat. Lyon, fasc.23, 13-79, 22 fig., 31 tabs., 4 pls.

GIULI, C. 1972: On the type form of *Equus stenonis* Cocchi. Palaeont. Italica, 38, 35-49, 3 figs, 11 tabs.

GROMOVA, V. 1949: Le genre *Equus*. Ann. du Centre d' Etudes et de Documentation Paléontologiques, 13, 1-203, 20 tabs, 9 pls.

KAUFFMANN, G.-KOCKEL, F. & MOLLAT, H. 1976: Note on the stratigraphic and paleogeographic position of the Svoula Formation in the innermost zones of the Hellinides (Northern Greece). Bull.Soc.Geol.France, 18, 2, 225-230.

KOCKEL, F. & MOLLAT, H. 1977: Erläuterungen zur Geologischen Karte der Chalkidiki und angrenzender Gebiete 1:100.000 (Nord-Griechenland) Bund.Geowiss.und Rohstoffe, 1-119.

KOUFOS, G.D. 1986a: The presence of *Gazella borbonica* (Bovidae, Mammalia) in the Villafranchian (Villanyian) of Macedonia (Greece) and its significance to the stratigraphic distribution of the species. N.Jb.Geol.Paläont. Mh., 1986, 541-554.

KOUFOS, G.D. 1986b: The presence of *Sus strozzi* in the Villafranchian (Villanyian) of Macedonia (Greece). Paläont.Z., 60, 341-351, 5 figs, 3 tabs.

KOUFOS, G.D. 1987: *Canis arnensis* DEL CAMPANA, 1913 from the Villafranchian (Villanyian) of Macedonia (Greece). Paleont. i Evolucio, 21, 3-10.

KOUFOS, G.D. & MELENTIS, J. 1983: New data from the Villafranchian mammal locality of Gerakarou (Macedonia, Greece). Proc.Acad.of Athens, 58, 181-185.

PRAT, F. 1968: Recherches sur les équides pleistocènes en France. Thèse de doctorat d' Etat ès Sciences Naturelles, Bordeaux, 1-325.

PSILOVIKOS, A. 1977: Palaeogeographic development of Mygdonia valley and the lake (Langada-Volvi area), (in greek with english summary). Doc.thesis,Univ. Thessaloniki, 1-154.

PSILOVIKOS, A. & SOTIRIADIS, L. 1983: The neotectonic graben complex of the Serbomacedonian massif at the area of Promygdonia Basin in northern Greece. Claust.Geol.Abh., 44, 22-52.

SAKELLARIOU-MANE, H., PSILOVIKOS, A. & KOUFOS, G.D. 1979: Contribution to the study of Villafranchian in Northern Chalkidiki (Macedonia, Greece), (in greek). Sci.Ann.Fac.Phys.Math.Univ. Thessaloniki, 19, 279-293.

SICKENBERG, O. 1968: Die pleistozänen Knochenbrekzien von Volax (Griech-Mazedonien). Geol.Jb., 85, 33-54, 3 taf.

ZAMANIS, A. - FAUGERES, L. - BONIS de L. - FOUNTOULIS, D. - SIMEAKIS, C. - PANAYOTIS, I. - DIMITRAKOPOULOS, R. & MERCIER, J.L. 1980: Découverte d'une faune de Mammifères du Quaternaire ancien dans les formations du lac Langada (Macédoine centrale, Grèce). Implications néotectoniques. C.R. Acad.Sci. Paris, D. 291, 813-816.