

FIRST RECORD OF DUGONGIDAE (MAMMALIA: SIRENIA) FROM THE FLORESTA CALCARENITES FORMATION (LATE BURDIGALIAN–EARLY LANGHIAN, REGGIO CALABRIA, SOUTHERN ITALY)

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Abstract. A sirenian rib has been recovered at Motta San Giovanni (Reggio Calabria) in the “Floresta Calcarenites”, a formation cropping out in Sicily and Calabria and dated late Burdigalian-Langhian. Although the rib is not a diagnostic bone for taxonomy, its presence in southern Calabria extends the knowledge about the paleobiogeography of the Family Dugongidae in the Mediterranean basin. The find is hitherto the only record of sirenians in the Floresta Calcarenites. Moreover, the specimen extends back to the Early-Middle Miocene (late Burdigalian-Langhian) the occurrence of sirenians in Calabria, previously determined based on substantial material from the Late Miocene (Tortonian) of the Monte Poro area (Vibo Valentia). The paleoenvironment of the Floresta Calcarenites was a warm and shallow sea, consistent with the paleoecology of Dugongidae.

INTRODUCTION

A rib referable to the Family Dugongidae has been recorded in the “Floresta Calcarenites” Formation cropping out at Motta San Giovanni, near Reggio Calabria (southern Italy; Fig.1). Calcarenites are locally named “Pietra di Lazzaro” and used as decorative stones.

The specimen was recovered during the cut of a block from a quarry located at “Contrada Salto”, near Motta San Giovanni (Reggio Calabria), 650-670m a.s.l., 38° 0' 1.035" N, 15° 42' 59.923" E.

Although the rib is not a diagnostic bone for taxonomy, its discovery is relevant to the distribution of Dugongidae in the Mediterranean Basin during the late Burdigalian-Langhian (late Early to Middle Miocene) and dates back the Sirenians' record of Calabria.

GEOLOGICAL SETTING

The “Floresta Calcarenites” Formation crops out in the Calabria-Peloritani Terrane (CPT), loca-

ted at the intersection between the NW/SE-trending southern Apennines and the SE-trending Sicilian Maghrebides. During the Early Oligocene, the CPT resulted from the emplacement of a fragment of the European margin onto the African paleomargin. The CPT lies on a Serravallian substratum and two superimposed tectonic units are present: “Sicilide” Unit, lower sequence of flyschoid deposits, variegated sandstones and andesitic tuffites; “Calabride” Unit, upper sequence of igneous and metamorphic nappes thrust onto the lower unit, with remnants of Meso-Cenozoic covers (Carbone et al. 1983, 2008; Carmisciano et al. 1981; Lentini et al. 1990). The tectonic units are unconformably covered by the “Capo d'Orlando” Flysch, late Oligocene-early Burdigalian in age (according to Carbone et al. 2008, 2011; Giunta et al. 2013). The “Antisicilide”, made up of varicoloured clays, overthrust the “Capo d'Orlando” Flysch during the mid-late Burdigalian (Carbone et al. 1993, 2008). The “Floresta Calcarenites” Formation (FC) lies on the Antisicilide clays, excluding some localities of eastern Peloritani, where it lies directly on the “Capo d'Orlando” Flysch or the crystalline basement (Carbone et al. 1993, 2008, 2011; Giunta et al. 2013). The FC Fm. is locally overlain by the “Motta” Flysch, a siliciclastic succession cropping out in Calabria and attributed

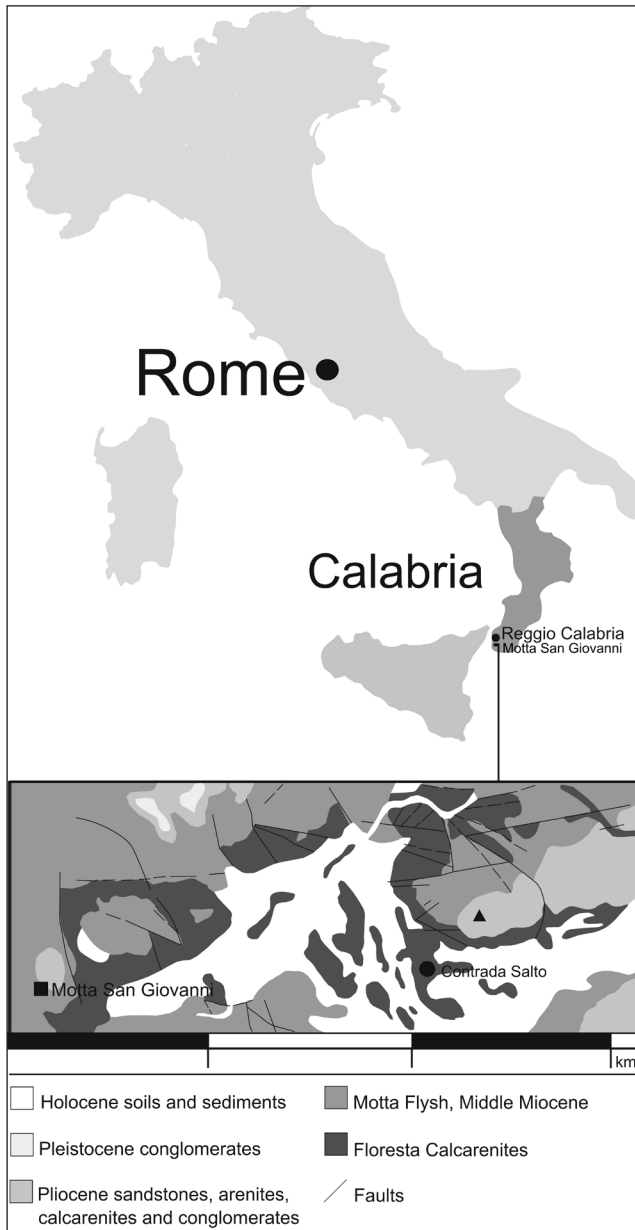


Fig. 1 - Geographical location of Motta San Giovanni and geological sketch map of the area.

to the Middle Miocene (Barrier et al. 1987).

The FC Fm. occurs in small isolated outcrops in the Peloritani, more frequently, and in the Aspromonte Mountains, and it is made up of sandstones with abundant calcareous cement and rich in bioclasts and siliciclasts, which can locally be conglomeratic.

Carbone et al. (1993) consider the scattered outcrops of the FC Fm. as the result of an extremely active synsedimentary tectonic regime, which involved the south-verging thrusting.

The calcarenites present two main *facies* related to different marine depths (Carbone et al. 1993): 1) shallow water *facies*, rich in bryozoans and rho-

dolites; deep water *facies* with mixed siliciclastic elements, related to resedimentation events.

The shallow-water *facies* is made of pale grey carbonates with reworked bryozoans and coralline algae, interpreted as near *in situ* packstones deposited on shallow ramp (less than 50 meters under the sea level; Buxton and Pedley 1989; Carbone et al. 1993). It is often overlain by bioclastic carbonates, locally cross-stratified (Carbone et al. 1993). The deep-water *facies* is resedimentated, and may present graded or massive strata. Carbonate and siliciclastic sediments were well washed before transportation, as indicated by the lack of fine grain matrix, and were deposited flowing down slopes (Carbone et al. 1993).

In the hypotheses sustained by Carbone et al. (1993), the most reliable source of siliciclastic materials is the subaerial erosion of small islands emerged for the strong tectonic activity. During late Burdigalian to early Langhian, these units developed diachronously as a consequence of the combined effects of marine eustatism and tectonism. Carbonate packstones rich in bioclasts were formed during a marine highstand in the shallow sea waters around the small islands (late Burdigalian); later the sea level fell and determined the end of carbonate deposition; shallower deposits were progressively dismantled and resedimentated in adjacent lows (Langhian). During the Serravallian, a marine highstand submerged the small islands and determined the extended deposition of clays in all areas (Carbone et al. 1993).

Lithostratigraphic correlations are very difficult, due to the short persistence of diachronic basins and the scattered distribution of outcrops.

Samples from the section of Monte Bammina (near Novara di Sicilia, Sicily) yielded a fauna of Foraminifera useful for dating. The basal levels have been attributed to the late Burdigalian due to the presence of *Globigerinoides trilobus*, *Globorotalia* [recte *Paragloborotalia*] *siakensis*, and *Globorotalia* [recte *Paragloborotalia*] *acrostoma*; the upper levels are attributed to the Langhian due to the presence of *Globigerinoides irregularis*, *Praeorbulina glomerosa glomerosa*, and *Praeorbulina glomerosa circularis* (Carbone et al. 1993).

At "Contrada Salto", the Floresta Calcarenites lie in concordance on the varicolored clays belonging to the Antisicilide complex. At the bottom, calcarenites lie slightly inclined, while at the top they may locally be cross-bedded. The Floresta Calcaren-

nites are overlain by Holocene deposits. In the quarry, the FC presents the *facies* of biolithites rich in bryozoans and rhodolites related to deposition in a warm shallow sea. Accordingly to the interpretation proposed by Carbone et al. (1993), the deposition of coralline algal packstones might be attributed to late Burdigalian.

SYSTEMATIC PALEONTOLOGY

Class **MAMMALIA** Linnaeus, 1758

Order **Sirenia** Illiger, 1811

Family Dugongidae Gray, 1821

Dugongidae indeterminate

Referred specimen: Left anterior rib (MPSNA unnumbered) embedded in matrix sectioned into a slab (Fig. 2).

Locality: Quarry at Contrada Salto, Motta San Giovanni (Reggio Calabria; 38° 0' 1.035" N, 15° 42' 59.923" E).

Formation: "Foresta Calcarenes" Formation.

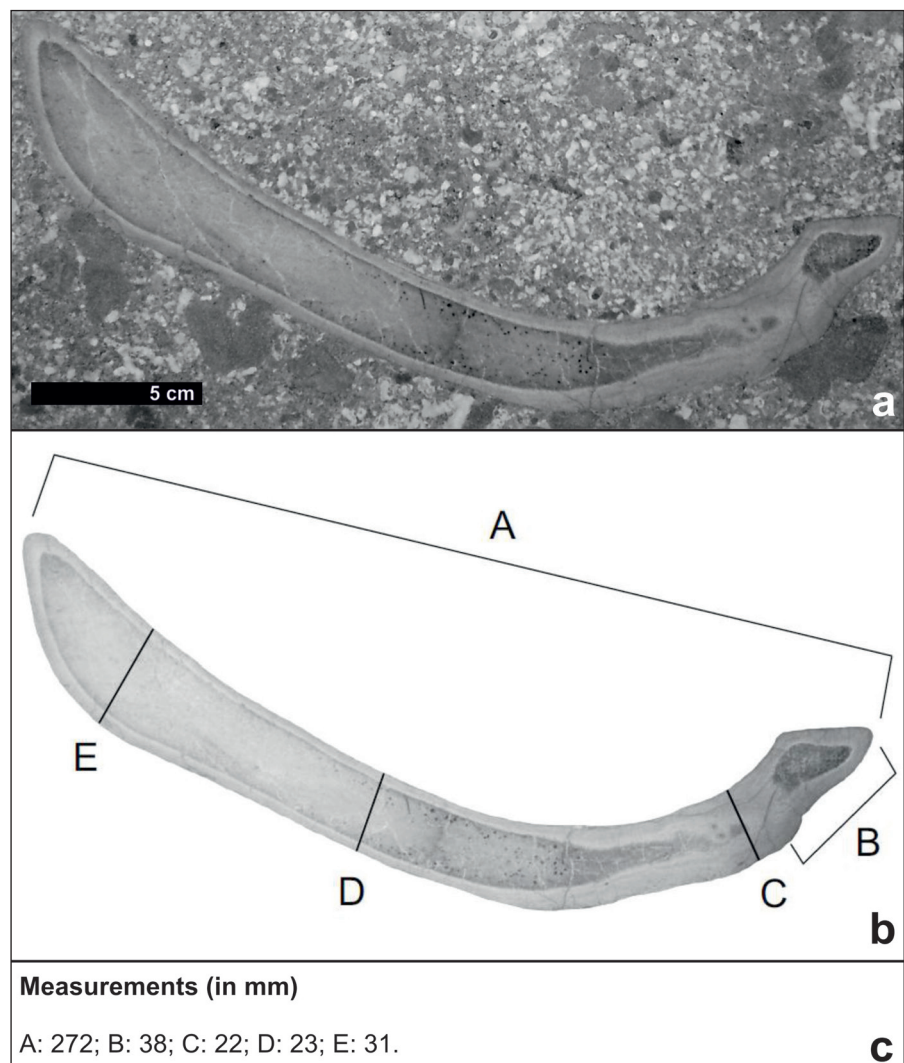
Age: Early-Middle Miocene, late Burdigalian-Langhian.

Repository: The specimen is kept in the collections of Museo di Paleontologia e Scienze Naturali del Parco dell'Aspromonte (Bova, Reggio Calabria)

Description. The anatomical terminology and measurements follow Domning (1978). The left rib is embedded in the carbonatic matrix and is preserved in a sectioned slab (Fig. 2a). Because of the commercial use of the calcarenites for floors, the rock and the embedded rib were sliced and polished to obtain a tile. The rib was not exposed, but it were noticed after the cut, as a dense (pachyosteosclerotic) bone showing a light brown outline and a dark interior. Descriptions and measurements are done on the bone included in the slab.

The proximal curvature (angle) is very slight; the capitulum is joined to the shaft by a thick neck. The tuberculum seems pronounced and extends up above the level of the neck. A ventral process is not present. The poorly developed articular processes suggest that the rib belonged to a young specimen.

Fig. 2 - Sirenian rib housed at MPSNA: a) specimen in the slab; b) plan of measurements: A - total length; B - tip of capitulum to lateral edge of tuberculum; C - proximal thickness; D - mid-shaft thickness, E - distal thickness; c) measurements.



Age	Locality	Formation	Collection and Catalogue Number	Skeletal Elements	Species	References
VIENNA BASIN (Paratethys)						
Burdigalian	Mägenwil, Argovia Canton (Switzerland)	?	NHMBe unnum.	Maxilla with teeth	<i>Metaxytherium studeri</i> = <i>M. krahuletzii</i>	Pilleri, 1987
Lower Burdigalian	Schindergraben, Eggenburg (Austria)	Burgschleinitz Form.	KME GII 21/34	Six isolate molars	<i>Metaxytherium krahuletzii</i>	Domning and Pervesler, 2001
	Burgschleinitz (Austria)		HMH 262	Skull fragments, maxilla		
IONIAN BASIN (Tethys)						
Langhian	Rdum tax-Xaghra, Gozo (Malta)	Upper Globigerina Limestone Member	NMNH-TF-01225	Rib fragment	Dugongidae indet.	Bianucci et al., 2011
Burdigalian-Langhian	Jabal Zaltan (Libya)	Garat Jahanam Member, Marada Formation	BMNH M45674	Skull, vertebrae and ribs	<i>Rytiodus heali</i>	Domning and Sorbi, 2011
	Apulia (Italy)	“Pietra Leccese”	?	?	<i>Metaxytherium</i> sp.	Bianucci et al., 2003
	Motta San Giovanni, Calabria (Italy)	“Floresta Calcarenes”	MPSNA unnum.	Rib	Dugongidae indet.	This paper
Late Burdigalian-Langhian	Qammieh, Mellieha, (Malta)	Upper Main Phosphorite Conglomerate Bed	NMNH TF-01226	Two incomplete ribs	Dugongidae indet.	Bianucci et al., 2011
Burdigalian	Mgarr ix-Xini, Gozo (Malta)	Lower Main Phosphorite Conglomerate Bed	NMNH TF-01227	Rib	Dugongidae indet.	Bianucci et al., 2011
Lower Miocene	Ragusa, Sicily (Italy)	Ragusa Form. Iminio Mm	BMNH M12607	Postcranial skeleton	<i>Metaxytherium</i> sp.	Hopwood, 1927
BALEARIC BASIN (Tethys)						
Burdigalian-Langhian	Son Morelló, Majorca (Spain)*	?	?	?	<i>Metaxytherium</i> sp.	Cañigüeral, 1952
	Olèrdola, Mas Romeu vell, Catalonia (Spain)	Cambrials Alcanar Groups	MV 1210	Skull, mandible, vertebrae, ribs.	<i>Metaxytherium catalaunicum</i> = <i>M. krahuletzii</i>	Piller et al., 1989
Late Burdigalian	Manosque, Provence (France)	“Molasse calcaire et sablo-marseuse”	MPNRL-MAN2000	Skull, vertebrae, ribs.	<i>Metaxytherium</i> cf. <i>krahuletzii</i>	Sorbi, 2008
Burdigalian	Beaucaire, Languedoc (France)	?	?	Skeleton (lost)	<i>Metaxytherium beaumonti</i> = <i>M. krahuletzii</i>	Depéret and Roman, 1920
TYRRENIAN BASIN (Tethys)						
Burdigalian-Langhian	Pianu di Bosa, Sardinia (Italy)	Modolo Formation	MDLCA unnumber.	Axis, three fragmentary vertebrae and ribs	<i>Metaxytherium cuvieri</i> = <i>M. cf. krahuletzii</i>	Comaschi-Caria, 1957
	Monte Alvu, Bosa, Sardinia (Italy)	Modolo Formation	MAC. PL1228	Zygomatic process of squamosal, teeth, incomplete mandible and ribs.	<i>Metaxytherium</i> cf. <i>krahuletzii</i>	Carone and Rizzo (Work in progress)
	Rosignano and Vignale, Piedmont (Italy)	Pietra da Cantoni Group	PU 13923/33,34	Two rib fragments	Sirenia indet.	Sorbi, 2007

Tab. 1 - Representative sirenian records from the western Mediterranean Basin during Burdigalian-Langhian time. Institutional abbreviations: BMNH = Natural History Museum, London, England; MAC = Museo di Storia Naturale Aquilegia, Cagliari, Italy; MDLCA = Museo Sardo di Geologia e Paleontologia Domenico Lovisato, Università di Cagliari, Cagliari, Italy; MPNRL = Maison du Parc Naturel Régional du Luberon, France; MPSNA = Museo di Paleontologia e Scienze Naturali del Parco dell'Aspromonte, Bova, Reggio Calabria, Italy; MV = Museu de Vilafranca, Vilafranca del Penedès, Spain; KME = Krahuletz-Museum, Eggenburg, Austria; NHM-Be = Naturhistorisches Museum, Bern, Switzerland; NMNH = National Museum of Natural History, Mdina, Malta; PU = Museo di Geologia e Paleontologia dell'Università di Torino, Torino, Italy.

The bulge in the distal portion of the shaft, and the thick neck, suggest that it is an anterior rib. The distal end tapers slightly to an oval termination, probably rugose, for cartilage attachment.

The rib from Motta San Giovanni does not represent a diagnostic skeletal element that can be taxonomically assigned below the level of Family. Its morphology is consistent with that of the Dugongidae, which is the only sirenian Family known from the Mediterranean Miocene. Measurements are within the variability of the Family Dugongidae (Fig. 2b and c).

DISCUSSION AND CONCLUSIONS

Dugongidae is a Family of extinct and living sirenians with a wide geographical and biostrati-

graphical distribution (Tab. 1, Fig. 3).

Fossils of Dugongidae have been collected in several Miocene localities of the Mediterranean region. During the latest Burdigalian-early Langhian, two sirenians, belonging to two distinct Subfamilies, were present in the Mediterranean Basin (Tab. 1, Fig. 3): *Rytiodus heali* (Dugongidae, Dugonginae), characterized by broad, mediolaterally-compressed, blade-like tusks with enamel mainly on the medial side, probably specialized as seagrass feeders that used their tusks in excavation of seagrass rhizomes; and *Metaxytherium* (Dugongidae, Halitheriinae) whose early and middle Miocene members (*M. krahuletzii* and *M. medium*, respectively) were characterized by small tusks and were probably adapted to a generalized seagrass diet.

Sirenian remains have been found in the Lo-

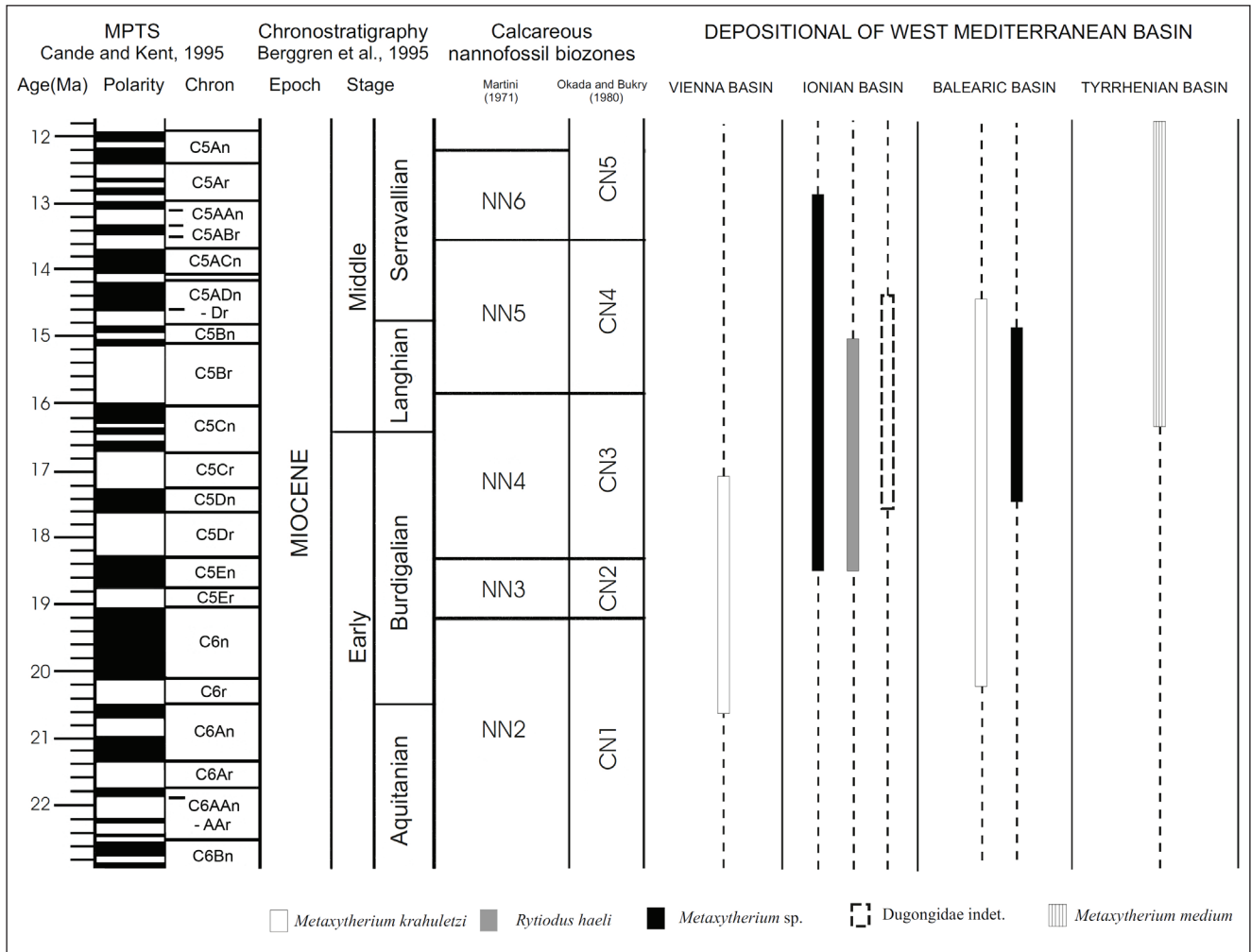


Fig. 3 - Stratigraphic distribution of Dugongidae spp. occurrences in the western Mediterranean basins. Abbreviations: VB, Vienna Basin; IB, Ionian Basin; BB, Balearic Basin; TB, Tyrrhenian Basin.

wer Miocene Marada Formation (Jabal Zaltan, Libya); most of these were described as *Rytiodus beali*, but some represent *Metaxytherium* sp. as well (Domning & Sorbi 2011). Some fragmentary remains referable to *Metaxytherium* come also from Malta, Gozo, Apulia and Sicily. Therefore in this area dugongines and halitheriines seem to have lived sympatrically.

Due to its morphology and taxonomic significance, the rib reported here could represent both sirenian taxa.

Nevertheless, the presence of a sirenian rib in the FC Fm. at Motta San Giovanni marks a new occurrence in the geographical distribution of Dugongidae in the Mediterranean area during the Early-Middle Miocene, often represented by scant materials roughly attributable to Dugongidae (Tab. 1).

Furthermore, the specimen represents the first record of sirenians in the Floresta Calcaren-

tes Formation, cropping out in southern Calabria and northeastern Sicily. The FC Fm. is represented by scattered and diachronical outcrops, whose different *facies* are interpreted as different phases of development through time (Carbone et al. 1993). Outcrops referable to pale grey carbonates with reworked bryozoans and coralline algae, like Motta San Giovanni ones, are representative of the first phase of deposition (late Burdigalian) and occur along the modern Thyrrhenian coast of NE Sicily and in the southern margin of Aspromonte in Calabria (Carbone et al. 1993). These packstones were formed on a ramp in shallow waters, deep less than 50 meters, as indicated by algal and foraminiferal associations, around the small islands emerged for tectonism (Carbone et al. 1993). This environment was favourable to sirenians.

Moreover, it is possible to infer a precise dating for the rib, if is accepted the development of

the FC Fm. *facies* sustained by Carbone et al. (1993), which consider the carbonatic packstones formed in a first depositional phase, attributable to late Burdigalian.

This find represents the earliest occurrence of sirenians in Calabria, previously represented only by abundant remains from the Late Miocene (Tortonian) of the Monte Poro area, near Vibo Valentia (Carone and Domning 2007).

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