

SHORT NOTE – NOTA BREVE

NEW SIRENIAN RECORD FROM LOWER PLIOCENE SEDIMENTS OF TUSCANY (ITALY)

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Abstract. A left humerus of a sirenian found in the upper part of a marine succession from Camigliano (Siena, Italy) is described. Foraminiferal assemblages reveal that this humerus belongs to a specimen living during the early Zanclean (*Globorotalia margaritae* Zone) in a shallow marine environment and that was probably subjected to post-mortem transport to a shelf environment under storm wave action. This new Tuscan record can be ascribed, for size and stratigraphic position, to *Metaxytherium* cf. *subapenninum*. The dimensional comparison of this humerus with those of its supposed ancestor *M. serresii* confirms the remarkable increase in body size of *M. subapenninum* compared with the former *M. serresii*.

Riassunto. Viene descritto un omero sinistro di sirenio proveniente dalla parte superiore di una successione di depositi marini affioranti presso Camigliano (Siena, Italia). Le associazioni a foraminiferi hanno evidenziato che questo omero apparteneva ad un esemplare che viveva durante lo Zancleano inferiore (Zona a *Globorotalia margaritae*), in una zona litorale e che fu probabilmente trasportato dopo la morte in un ambiente di piattaforma a seguito dell'azione di correnti di tempesta. Il reperto è attribuibile per taglia e posizione stratigrafica a *Metaxytherium* cf. *subapenninum*. Il confronto dimensionale di questo omero con quelli appartenenti al suo presunto antenato *M. serresii* conferma il notevole incremento di taglia di *M. subapenninum* rispetto a *M. serresii*.

Introduction

Sirenians are herbivorous marine mammals represented only by four living species: the Dugongidae *Dugong dugon* (Müller, 1776) Palmer, 1895 inhabiting both the Indian and SW Pacific Oceans, and the three species

of Trichechidae (manatees) living in rivers and coasts of Atlantic Ocean.

While Sirenians are now extinct in the Mediterranean, the fossil record provides evidence for their presence from the Middle Eocene to the Middle Pliocene (Domning 1994). From the Middle Miocene, however, the only sirenians surviving in the Mediterranean region belonged to the cosmopolitan halitheriine genus *Metaxytherium*. This genus showed a wide geographical and stratigraphical distribution during the Miocene, in fact, *Metaxytherium* remains have been collected in several Miocene deposits of the Mediterranean, Paratethyan, Northeastern Pacific, Northeastern Atlantic, and Western Atlantic – Caribbean regions. In contrast during the Pliocene survived only in the Mediterranean area and probably along the Atlantic coast of Morocco, and became extinct in the Middle Pliocene (see Domning 1996 for references).

The Mediterranean appears therefore a crucial area in the *Metaxytherium* history. In this region *Metaxytherium* was represented by four species (Domning & Thomas 1987; Domning & Pervesler 2001; Bianucci et al. 2004): *M. krabuletzii* Depéret, 1895 (Burdigalian); *M. medium* (Desmarest, 1822) Hooijer, 1952 (Langhian to Tortonian); *M. serresii* (Gervais, 1847) Depéret, 1895 (latest Tortonian to early Zanclean) and *M. subapenninum* (Bruno, 1839) Fondi & Pacini, 1974 (Zanclean to Piacenzian). These species seem to represent a single lineage characterized by slight morphological changes from *M. krabuletzii* to *M. medium* and by an ecophe-

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notypic dwarfing in *M. serresii*, attributed it to suboptimal foraging habitat in the wake of the Messinian Salinity Crisis, and followed by a notable increase in body size in *M. subapenninum* (Domning & Thomas 1987; Bianucci et al. 2004).

A left sirenian humerus, collected by Simone Casati in the Lower Pliocene sediments of Camigliano (Siena, Italy) and now kept in the Museo di Geologia e Paleontologia dell'Università di Firenze (IGF) is described and compared with other humeri belonging to the Mediterranean Pliocene sirenians to investigate this increase in body size occurred during the Pliocene.

Anatomical terminology and measurements follow Domning (1988).

Foraminiferal assemblages and interpretation

The humerus was collected in the Camigliano area (Fig. 1) at about 2.8 m from the base of a section (lat 43° 01' N; long 11° 24' E) about 3.3 m thick consisting of coarse sands with very fine pebbles, passing upward to fine and silty sands with intercalated sand layers. These sediments are referred to the Early Pliocene marine ingression, dated to the *Globorotalia margaritae* Zone and overlying lake deposits attributed to the Late Miocene and possibly to the basal Pliocene (Damiani et al. 1980).

Analyses of foraminiferal assemblages define the paleoenvironmental and biostratigraphical framework

of the section (Fig. 2), integrating data derived from this sirenian fossil.

Coarse sand samples from the lower part of the section (sample 1 and 2) show rare and poorly preserved benthic foraminifers mainly referred to *Ammonia beccarii* and *Asterigerinata planorbis*. Planktonic species are absent with the sole exception of a few specimens of *Orbulina universa* observed in sample 2. Both foraminiferal assemblages and preservation state of the taxa are typical for a coastal environment.

Fine and silty sand samples of the upper part of the section (samples 3 and 7) display foraminiferal associations characterised by more than 60% of benthic specimens, including mainly *Cassidulina laevigata*, *Cibicidoides* spp., *Lenticulina* spp., *Marginulina costata*, *Siphonina* spp., *Uvigerina* spp., and subordinate *Ammonia beccarii*, *Bolivina* spp., *Bulimina* spp. and *Elphidium crispum*. The common planktonic species *Globigerina bulloides*, *Globigerinoides obliquus obliquus* and *Orbulina universa* have been observed in association with rare specimens of *Globorotalia margaritae*. These foraminiferal assemblages display a considerable diversity of species mainly indicative of shelf and slope environments; however, nearshore and probably displaced taxa, such as *Ammonia beccarii* and *Elphidium crispum*, are also observed (Fig. 2). A more diversified but similar foraminiferal fauna, attributed to the outer neritic zone (possibly corresponding to outer shelf), has been observed in Lower Pliocene sediments from Tuscany by Bossio et al. (1991a – c; 2004). Estimates of planktonic/benthic foraminiferal ratios suggest deposition at a depth of about 150 m (van der Zwaan et al. 1990). These assemblages are considered to reflect deposition in an outer shelf environment.

Samples 4, 5 and the sample associated with the humerus (sample 6, Fig. 2) have been collected in a sand layer intercalation and show poorly preserved benthic foraminifers including mainly *Ammonia beccarii*, *Asterigerinata planorbis*, *Nonion boueanum*, *Elphidium* spp., *Lenticulina* spp., *Uvigerina* spp., and rare planktonic species (*Globigerina bulloides*, *Globigerinoides obliquus obliquus* and *Orbulina universa*). These foraminiferal faunas include both shallow marine and a small number of relatively deep marine species (*Lenticulina* spp., *Uvigerina* spp.), showing a preservation state indicative of transport or reworking. These sediments are possibly transported from shallow marine areas or older units and deposited in a shelf environment under storm wave action.

Microfaunal analyses allow a reliable biostratigraphic attribution for the upper part of the section, which is assigned to the *Globorotalia margaritae* Zone (Cita 1975; Iaccarino 1985), dated to about 5.08 – 4.52 Ma, according to the biochronology of the Mediterra-

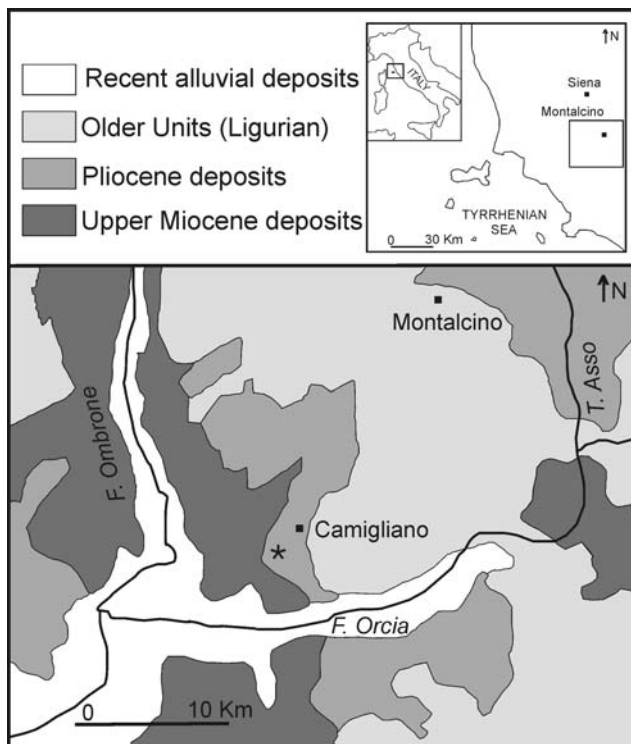


Fig. 1 - Geographic location of the Camigliano area. The black star indicates the section where IGF 8743V was collected (Modified from Bonini et al. 1999).

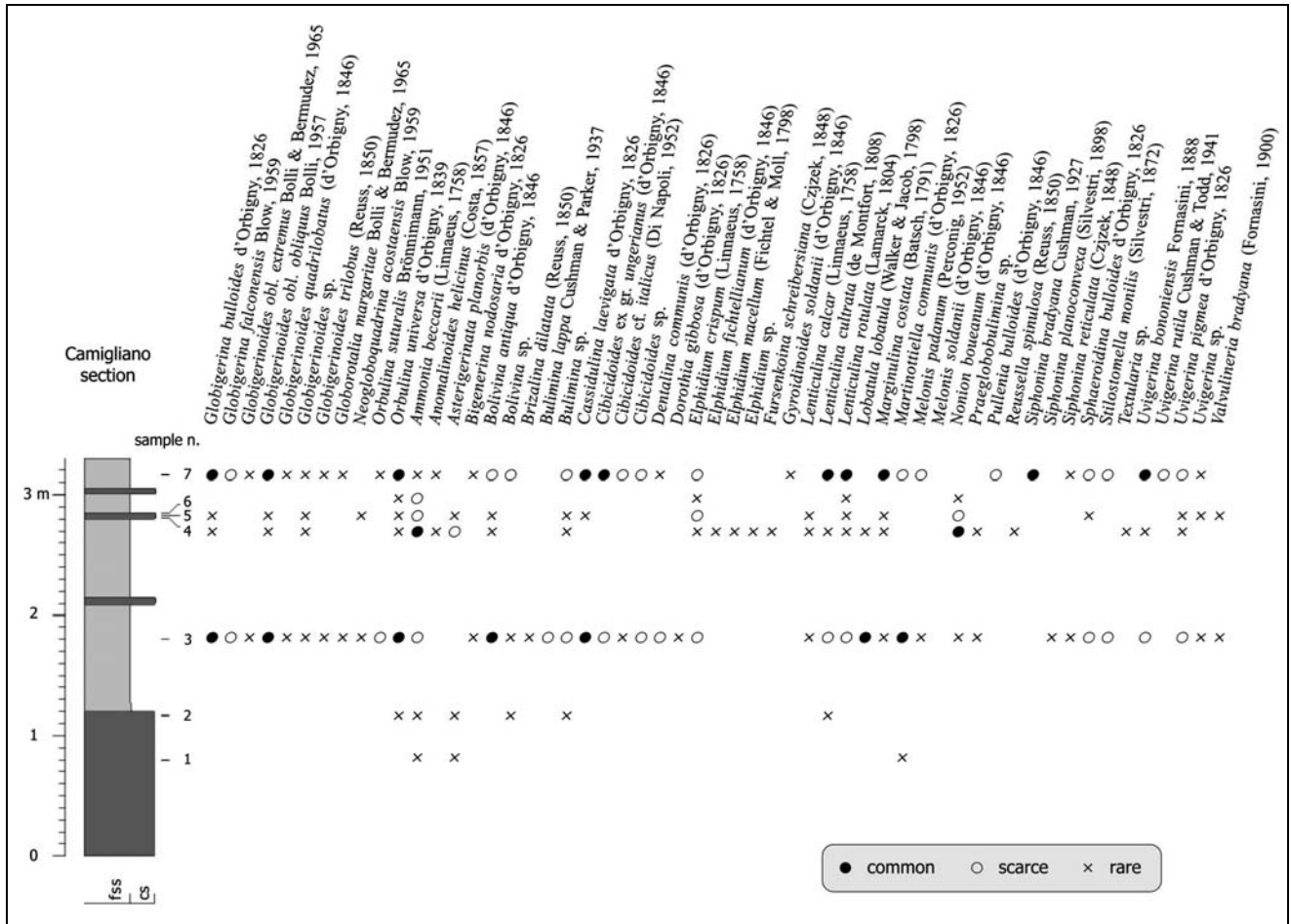


Fig. 2 - Distribution of foraminifers in the Camigliano section. Number of foraminifers in a splitted portion of sample (9 mg for samples 1 and 2; 3 mg for samples 3-7): common = more than 9 specimens; scarce = 4 – 9 specimens; rare = 1 – 3 specimens. Lithology: cs = coarse sand; fss = fine and silty sand.

nean planktonic foraminiferal events by Lourens et al. (1996).

Foraminiferal assemblages reveal a rapid deepening-upward tendency of this succession, from coastal to outer shelf environments subjected to storm wave action. A comparable trend has been recently observed in deposits attributed to the *Globorotalia margaritae* Zone from southern Tuscany (Bossio et al. 2004).

Systematic paleontology

Class **Mammalia** Linnaeus, 1758

Order **Sirenia** Illiger, 1811

Family **Dugongidae** Gray, 1821

Subfamily **Halitheriinae** (Carus, 1868) Abel, 1913

Genus *Metaxytherium* de Christol, 1840

Metaxytherium cf. **subapenninum** (Bruno, 1839) Fondi e Pacini, 1974

Fig. 3; Pl. 1

Referred specimen. IGF 8743V left humerus.

Locality. Camigliano (Siena, Italy).

Age and stratigraphic occurrence. Early Pliocene, Zanclean, *Globorotalia margaritae* Zone.

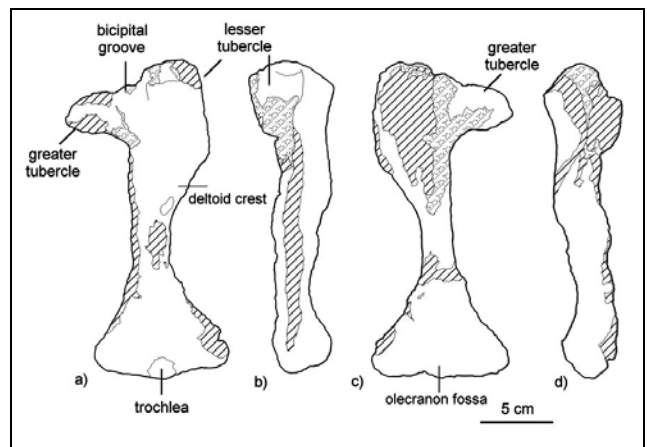


Fig. 3 - IGF 8743V, humerus of *Metaxytherium* cf. *subapenninum* from Lower Pliocene of Camigliano, Siena. Humerus in dorsal (a), medial (b), ventral (c) and lateral (d) views. Lines indicate eroded portions; points indicate hard sediment.

Description. IGF 8743V is a 242 mm long, left humerus of a sirenian, subjected to post-mortem transport to a shelf environment under storm wave action and therefore damaged by erosional processes. The proximal epiphysis is about 108 mm wide, the deep bicipital groove is 30 mm wide but its length is not definable. The head is not preserved. The greater tubercle is well developed, it bears an anteromedial flange and large rugosities for supraspinatus and infraspinatus insertions. The lesser tubercle lacks the proximal part; the preserved distal part is proximo-medially inclined. Tubercles diverge at an angle of about 65°. The shaft appears very slender, because of the erosion. On the dorsal side, only the proximal part of the deltoid crest is preserved; it is distal to the deltoid tuberosity and it is prominent and recurved. The rugose *teres pectoralis* insertion is partially preserved in the middle of the shaft, on the ventral side. The distal epiphysis is dorsoventrally narrower and mediolaterally wider than the proximal epiphysis, maybe as a result of diagenetic distortion. The olecranon fossa is shallow but well defined. Only the central portion of the trochlea is preserved and the angle with the shaft is not determinable.

Comparison. The humerus IGF 8743V is referable to the Dugongidae because, as those of other dugongids, it is dumbbell-shaped, with large tubercles and

a deep bicipital groove (Domning 1988); but its state of conservation does not permit a specific determination.

Anyway *Metaxytherium* is the only known sirenian genus in the Pliocene of the Old World and it is represented by two species: the small species *M. serresii* (uppermost Tortonian to early Zanclean) and the large species *M. subapenninum* (Zanclean to Piacenzian).

Only one other sirenian humerus is known from the Lower Pliocene of the Italian deposits. This bone (DSTG 2519 in Tab. 1), found in De Ferrari Square of Genoa (North Italy), was referred to *Felsinotherium* sp. (= *Metaxytherium*) by Issel (1912). This bone, of which only the distal portion is now preserved and kept at the Museo Paleontologico dell'Università degli Studi di Genova (DSTG), appears to be intermediate in size between *M. serresii* and IGF 8743V (Tab. 1). On the contrary the IGF 8743V is substantially bigger than the humeri referred to *M. serresii* and, even if any humerus of *M. subapenninum* is known allowing a direct comparison (see Tab. 1), the size of IGF 8743V appears to be consistent with the estimated body size of *M. subapenninum*.

Conclusions

The humerus IGF 8743V is attributable by its size and stratigraphic position to *Metaxytherium* cf. *subapenninum* (Bruno, 1839) Fondi e Pacini, 1974.

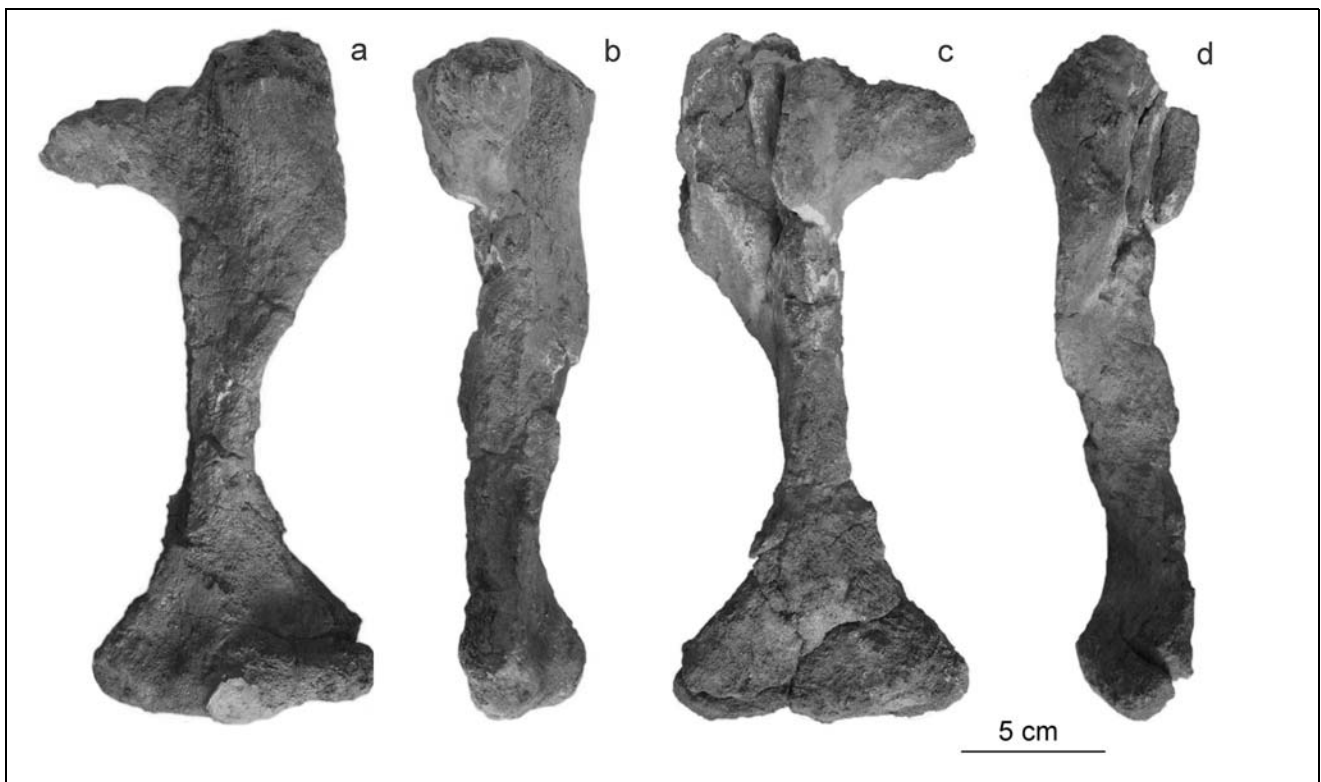


PLATE 1

IGF 8743V, humerus of *Metaxytherium* cf. *subapenninum* from Lower Pliocene of Camigliano, Siena. Humerus in dorsal (a), medial (b), ventral (c) and lateral (d) views.

Measurements (in mm) of humeri (Domning 1988)											
AB	Total length = Maximum length, greater tubercle to distal end										
CD	Maximum breadth, greater to lesser tubercle										
EF	Maximum breadth, ectepicondyle to entepicondyle										
GH	Maximum thickness, posterior side of head to anterior side of greater tubercle										
IJ	Maximum thickness, posterior to anterior ends of medial rim of trochlea										
KL	Maximum diameter of head										
MN	Minimum diameter of head										
OP	Breadth of anterior side of trochlea										
QR	Length, saddle between head and greater tubercle to saddle of trochlea										
<i>M. serresii</i>			from Domning & Thomas 1987								
Libya			AB	CD	EF	GH	IJ	KL	MN	OP	QR
GUDGb 126P15A	left	..	>58	>55	>71	..	..	..	..	..	>149
GUDGb 126P15A	left	180	83e	66	85e	28	51	47	47	154	
GUDGb 7P66A	left	..	89	73	89	32	56	51e	51	..	
GUDGb 46P66A	left	..	..	61	..	20	..	..	44	..	
GUDGb 49P66A	right	183	76	>60	79	..	>42	..	..	159	
GUDGb 72P66A	left	190	86	68	84	32	48e	41	49	159	
GUDGb 12P115B	left	158	68	59	73	25	42	37	40	133	
<i>M. serresii</i>			Domning pers. comm.								
France			AB	CD	EF	GH	IJ	KL	MN	OP	QR
MNHN 2260	left	179	85	71	78	26	49	39	51	154	
MNHN 1868-233	right	..	85	..	80	..	52	44	..	..
NHMB MP705	left	184	93	80	85	26	46	56	54	157	
NHMB MP706	left	..	71	..	..	22	..	..	46	125	
NHMB MP641	right	..	76	..	74	..	40	44	..	..
NHMB MP1036	left	..	85	..	81	..	44	50	..	..
NHMB MP707	left	..	85	..	85	..	46	53	..	..
<i>M. cf. subapenninum</i>			* specimen illustrated by Issel (1912)								
North Italy			AB	CD	EF	GH	IJ	KL	MN	OP	QR
DSTG 2519*	right	197	80	>45	..	20	..	..	..	170	
IGF 8743V	left	242	108	103	..	31	..	..	..	218	

Tab. 1 - Measurements (mm) of IGF 8743V compared with other humeri belonging to *M. serresii* and *M. cf. subapenninum*. Abbreviations: e estimated; DSTG Museo Paleontologico dell'Università degli Studi di Genova, Italy; GUDGb Garyounis University Department of Geology, Benghazi, Libya; IGF Museo di Geologia e Paleontologia dell'Università di Firenze, Italy; MNHN Museum National d'Histoire Naturelle, Paris, France; NHMB Naturhistorisches Museum, Basel, Switzerland.

The dimensional comparison of fossil humeri belonging to Pliocene *Metaxytherium* species (Tab 1) confirms the remarkable increase in body size of *M. subapenninum* compared with *M. serresii*, possibly attributed to a post-Messinian re-establishment of the sea-grass habitat (Domning & Thomas 1987; Bianucci et al. 2004). This size trend is consistent with that observed by Bianucci et al. (2004) using the cranial measurement of the breadth across the occipital condyles of about twenty selected specimens.

The analyses of foraminiferal assemblages reveal that the humerus IGF 8743V, found in the Camigliano section, belongs to a specimen living between about 5.1

and 4.5 Ma (lower part of the Zanclean) in a shallow marine environment (possibly shoreface) and was subjected to a post-mortem transport to a shelf environment under storm wave action.

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