Ann. Naturhist. Mus. Wien	102 A	51–67	Wien, Februar 2001

Strombus (Dilatilabrum) roegli sp. nov.

-

a giant Oligocene strombid (Gastropoda) and its bearing on palaeoclimatic reconstructions of the Western Tethys

by Mathias HARZHAUSER[1]

(With 2 text-figures and 3 plates)

Manuscript submitted October 16th 2000,
the revised manuscript October 30th 2000.

Abstract

A giant, winged *Strombus* from Oligocene-Lower Miocene nearshore deposits of the Mesohellenic Basin (NW Greece), the Esfahan-Sirjan Basin (Central Iran) and the Qom Basin (Central Iran) is described as a new species, *Strombus roegli*. Relationships to other Oligocene and Miocene strombids and its subgeneric placement within *Dilatilabrum* are discussed. The exceptionally large size of *Strombus roegli* and its abundance are interpreted as a Chattian strombid event in the eastern part of the Western Tethys, which indicates a distinct warming trend.

Keywords: *Strombus roegli*, *Dilatilabrum*, *Tricornis*, Strombidae, Oligocene, Eastern Mediterranean, Climate, Palaeobiogeography, Mesohellenic Basin, Esfahan-Sirjan Basin, Qom Basin.

Zusammenfassung

Ein neuer großwüchsiger, geflügelter *Strombus* aus oligozänen, seicht marinen Ablagerungen des mesohellenischen Beckens (NW Griechenland), dem Esfahan-Sirjan Becken (Iran) und dem Qom Becken (Iran) wird als neue Art beschrieben. Beziehungen zu anderen oligozänen und miozänen Strombiden sowie die subgenerische Zuordnung zu *Dilatilabrum* werden diskutiert.

Die ungewöhnliche Größe und die Häufigkeit werden als Hinweis auf ein Strombiden-Event im Chattium der östlichen West-Tethys interpretiert, das einen "mitteloligozänen" Erwärmungstrend anzeigt.

Schlüsselwörter: *Strombus roegli*, *Dilatilabrum*, *Tricornis*, Strombidae, Oligozän, Ostmediterran, Klima, Paläobiogeographie, Mesohellenisches Becken, Esfahan-Sirjan Becken, Qom Becken.

Introduction and regional setting

A remarkable new strombid species (*Strombus roegli*) was found during fieldwork supported by the DFG/FWF project on the palaeobiogeography and palaeogeography of the Eastern Mediterranean and Western Indo-Pacific in the Oligocene and Lower Miocene. The best-preserved and richest material derives from the Mesohellenic Basin in Greece.

[1] Dr. Mathias HARZHAUSER, Geologisch-Paläontologische Abteilung, Naturhistorisches Museum Wien, Burgring 7, Box 417, A-1014 Vienna, Austria; e-mail: mathias.harzhauser@nhm-wien.ac.at

Further specimens were found in the Esfahan/Sirjan and the Qom Basins in Central Iran. At all sections the strombid bearing layers are characterised by siliciclastic sediments with corals, larger foraminifera and a highly diverse mollusc fauna, indicating marine conditions in lagoonal and/or shallow sublittoral settings. Reliable biostratigraphic dating is based on planktonic foraminifera and to some extent also on analysis of the larger foraminifera (STEININGER & al. in prep.; SCHUSTER & WIELANDT 1999).

Strombus roegli is the largest *Strombus* recorded from the Western Tethys and seems to be the largest Oligocene strombid, apart from *Oostrombus irregularis* (FUCHS), which lived in association with *Strombus roegli*. The new species was probably restricted to the Eastern Mediterranean area, since it has never been reported from the well studied sections in the Western Mediterranean.

In the following only a brief description of the investigated sections is given. A detailed report of the sedimentology, biostratigraphy and palaeoecology of the sections is partly presented in SCHUSTER & WIELANDT (1999) and will be given in STEININGER & al. (in prep.).

1. Greece

Doutsiko section (40° 07' 65 N, 21° 08' 45 E), Mesohellenic Basin, Greece

Numerous specimens, including the holotype, were collected from the section at Doutsiko, within the Mesohellenic Basin in north-western Greece. The sequence comprises more than 1400 m of a mainly siliciclastic succession with minor limestone intercalations, exposed between two villages, Mesolouri (base, 40° 06' 62 N, 21° 08' 84 E) and Doutsiko (top, 40° 07' 65 N, 21° 08' 45 E). Close to Doutsiko, the Chattian part of the section starts with 140 m of interbedded sandy-silty marls and sandstones bearing a 3 m thick layer of coral-limestone at 70 m. This unit is overlain by 180 m of intercalated sandy-silty marls to sandstones and poorly cemented sand. A 3 m thick layer of coral-limestone with *Strombus roegli*, molluscs, lepidocylinids, and rhodoliths is followed by 10 m of lepidocyclinid-marls.

B i o s t r a t i g r a p h y : Larger foraminifera date the strombid-bearing section near Doutsiko to Chattian (STEININGER & al. in prep.).

2. Iran

Abadeh section (31° 30' 61 N, 52° 43' 99 E), Esfahan-Sirjan Basin, Iran

The section is located 40 km NNE of the city of Abadeh (Central Iran) and consists of about 164 m of Oligocene siliciclastic sediments and limestones. The base of the section is made up by variegated, continental deposits of the Lower Red Formation. Up-section, two transgressional cycles are exposed: the first marine ingression is indicated by about 70 m of reddish marls. Corals, scattered irregular echinoids and abundant crustacean burrows characterise the fauna of the marly basal part. Towards the top of this unit, small patch reefs develop, accompanied by large gastropods such as *Strombus roegli*. Unit 2 consists of about 50 m of marls, marly limestones and limestones. At the base there is a polymict conglomerate, followed by a marly layer with a diverse, recrystallised mollusc fauna. The overlying limestones contain corals, echinoids and corallinaceans; the intercalated marls are rich in lepidocyclinids. Approximately 45 m of massive coral-

and corallinacean-limestones form the top of the section. *Strombus roegli* was found associated with the patch-reefs of unit 1 as well as in the base of unit 2.

B i o s t r a t i g r a p h y : The lowermost part of the marly unit at the base of the Abadeh section is dated as Lower Oligocene (Rupelian) from the occurrence of *Nummulites sublaevigatus*. Lepidocyclinids and planktonic foraminifera constrain the overlying strombid-bearing part of the section to the early Late Oligocene (zone P21b).

Zefreh section (32° 56' 60 N, 52° 08' 39 E), Esfahan-Sirjan Basin, Iran

The approximately 275 m thick section Zefreh is located 50 km ENE of Esfahan. The basal unit starts with a conglomerate and 10 m of sandstones, and passes into 30 m of marls with thin layers of siltstone and scattered layers of molluscs. Rare specimens of *Strombus roegli* have been observed within these marls. Up-section, 35 m of biogenic limestones and calcareous marls with corallinaceans and corals follow. Above these, a 60 m thick unit of biogenic limestones, an intercalation of marly limestones, bearing abundant foraminifera, corallinaceans, molluscs, and echinoids crops out. It is followed by 85 m of limestones and sandy limestones of Lower Miocene age, in which with mass occurrences of larger foraminifera are developed. The top of the section is formed by yellowish marls with abundant pectinids, clypeastrids, and larger foraminifera. *Strombus roegli* was found in the basal marls as well as in the very top of the section.

B i o s t r a t i g r a p h y : The occurrence of *Miogypsina (Miogypsinoides) dehaarti* at the top of the section indicates a Lower Miocene (Aquitanian) age (CHAHIDA & al. 1977). The planktonic fauna also indicates a Lower Miocene age (F. RÖGL, pers. comm.).

Chalehghareh section (34° 46' 99 N, 51° 43' 76 E), Qom Basin, Iran

The 315 m thick section of Chalheghareh is located on the road from Esfahan to Kashan, 45 km north of Natanz, north-west of the small village of Chalheghareh. Continental deposits of the Lower Red Formation are transgraded by the marine Qom Formation. About 50 m, partly crossbedded, sandy corallinacean limestones form the base of the marine sequence. Corallinacea, irregular echinoids and oysters dominate the fauna. These are overlain by 100 m greenish *Lepidocyclina*-marls, containing abundant larger foraminifera and bryozoans, along with bivalves, echinoids, and corallinaceans. Up-section, 60 m of trough cross-bedded or laminated marls and marly limestones crop out. Oolithic limestones and layers with monospecific mass-occurrences of potamidids and scattered plant debris are typical. The subsequent 100 m of marly limestones and marls are characterised by turritellid-mytilid coquinas and oyster beds, which pass vertically into marly limestones with abundant infaunal bivalves. The marly top of the unit bears some c. 10 m thick gypsum layers, which have been exploited in several small pits. The uppermost 20 m of the section consist of marly limestones and limestones which bear two horizons of the tube-like bivalve *Kuphus*.

B i o s t r a t i g r a p h y : The lepidocyclinid fauna from the marls of the lower part of the section indicates a Late Oligocene age (U. WIELANDT-SCHUSTER, pers. comm.). Up-section, the occurrence of *Miogypsinoides formosoides* and *Miogypsinoides bantamensis* marks the base of the Aquitanian. All strombids from the Chalehghareh section derive from the Aquitanian part of the sequence.

Fig. 1: Location of the investigated sections in Greece and Iran (map after STEININGER & al. in prep. modified).

Systematic description

Class: Gastropoda, CUVIER, 1797

Superfamily: Stromboidea RAFINESQUE, 1815

Family: Strombidae SWAINSON, 1840

Genus: *Strombus* LINNÉ, 1758

Subgenus: *Dilatilabrum* COSSMANN, 1904

Strombus (Dilatilabrum) roegli sp. nov.

1999 *Strombus* sp. – SCHUSTER & WIELANDT: 577.
2000 *Strombus (Tricornis)* nov. sp. – HARZHAUSER:.150.

H o l o t y p e : The specimen illustrated in pl. 1, fig. 1. (Inv. NHMW 2000z0137/0001)

P a r a t y p e s : The remaining specimens in pl. 2-3.

All specimens are stored at the collection of the Museum of Natural History Vienna (NHMW).

D e r i v a t i o n o m i n i s : In honour of Dr. Fred RÖGL, now retired palaeontologist at the Museum of Natural History, Vienna. Together with Prof. Dr. Fritz F. STEININGER he found the new giant *Strombus* during fieldwork in the 1980's. In 1998 he helped the author to collect the holotype from a strongly lithified sandstone bed at Doutsiko (Greece).

T y p e l o c a l i t y : Doutsiko, Mesohellenic Basin, Greece.

T y p e h o r i z o n : Late Oligocene (Chattian).

D e s c r i p t i o n : Shell very thick and extremely massive. Protoconch destroyed in all available specimens. Moderately tall spire formed by the early 5 to 6 whorls with an apical angle between 60° to 80°. These spire whorls are slightly convex, decorated (sometimes) by five weak spiral ribs in their anterior half and bear marginal knobs at the anterior suture. The following 2 or 3 whorls get abruptly broader and form a bulgy sutural shelf, separated only by deeply incised, irregular, wavy sutures. At the transition from the sutural shelf to the flank the body whorl bears a prominent bulge from where the base contracts rapidly in a marked concavity and terminates in a strongly deflected canal. Although the shoulder is formed by a heavily thickened and somewhat asymmetric callous bulge, no spines are observed at any investigated specimen. On the ventral side this bulge may sometimes even expand in posterior direction, thus towering the spire markedly. Dorsally the body whorl is strongly concave; no sculpture is developed but faint growth lines. On the base, the shell is slightly flattened and develops a thick columellar callus. Columella and aperture are smooth.

The body whorl ends in a giant wing. The bulgy angulation of the last whorl holds on to this wing where it forms a prominent edge. The adaxial, posterior part of the wing is straight or concave, whereas the abaxial part is well-rounded and passes into a very shallow stromboid-notch. Canal bent and narrow. Outer lip very thick, broadly flared, with a very high posterior expansion that exceeds the spire distinctly.

Adult shells are totally smooth. However, shells of juveniles or broken adults, which still show the flanks of early whorls, display close-set, rounded spiral-ribs on the base.

The total height of adult shells usually attains about 24 cm. Casts at the sections Chalehghreh and Zefreh, measured in the field, suggest maximum sizes up to 30 cm.

I n t r a s p e c i f i c v a r i a b i l i t y : The vast number of shells observed in the field document a rather low variability concerning the wing form and the stromboid notch. In contrast, the spire height and the apical angle vary widely. Similarly, the swelling along the ventral side of the body whorl, which sometimes even exceeds the spire, is very variable.

M a t e r i a l : 10 shells from Doutsiko (Greece), 1 shell and 1 cast from Abadeh (Central Iran), 1 cast from Chalehghareh (Central Iran), and 3 casts from Zefreh (Central Iran). All specimens are stored in the collection of the Geological-Paleontological Department at the Museum of Natural History Vienna.

Inv. Number Mus. Nat.Vienna	**section**	**height** (-wing)	**height** (+wing)	**diameter** (-wing)	**diameter** (+wing)
2000z0137/0001	Doutsiko (**holotype**)	>180 mm	>240 mm	120 mm	196 mm
2000z0137/0002	Doutsiko (shell)	>190 mm	>220 mm	108 mm	>190 mm
2000z0137/0003	Doutsiko (shell)	160 mm	215 mm	>104 mm	185 mm
2000z0137/0004	Doutsiko (shell)	-	-	115 mm	>170 mm
2000z0137/0005	Doutsiko (shell)	>180 mm	-	>113 mm	-
2000z0138/0001	Abadeh (juv. shell)	> 57 mm	-	39 mm	50 mm
2000z0139/0001	Zefreh (cast)	>210 mm	-	130 mm	>240 mm
2000z0139/0002	Zefreh (cast)	>140 mm	-	115 mm	-

Comparison with other Oligocene and Lower Miocene strombids

No giant *Strombus* species has been described previously from the Oligocene of the Mediterranean area. Although strombids such as *Oostrombus irregularis* (FUCHS) and *Oostrombus auriculatus* (GRATELOUP) attain sizes up to 20 cm, they differ very distinctly from *Strombus roegli* in their typical spire structure. Amongst the more closely related strombids only *Strombus radix* (BRONGNIART, 1823) has been documented from the Oligocene of the Eastern Mediterranean (BENEVENTI & PICCOLI 1969). However, this species can be easily distinguished by its smaller size, its spiral ornamentation, the strong nodes or spines and by the wing, which never exceeds the spire.

Generally, the Oligocene strombid diversity is low in the Mediterranean area, when only the advanced *Strombus* type is considered, but a large number of *Strombus* species have been described from the contemporaneous European Atlantic. The Oligocene *Strombus sublatissimus* d'ORBIGNY from the Adour Basin (France) is very similar. This species was originally illustrated by GRATELOUP (1840) and equated with the extant *Strombus latissimus* LINNÉ until d'ORBIGNY (1852) recognised the mistake and renamed it *Strombus sublatissimus*. The wing structure is rather similar to that of *Strombus roegli* and it also develops a marked angulation running from the shoulder into the very posterior tip of the wing. Moreover, *Strombus sublatissimus* attains a similar size as *Strombus roegli*. Nevertheless it differs strongly by its spiral ornamentation and its rounded adsutural part of the body whorl. In contrast, *Strombus roegli* has a pronounced shoulder, which forms a distinct angulation between the flank and the adsutural part of the last whorl. In addition, none of the adult specimens and wing fragments shows any spiral ornamentation. As far as can be judged from the poor drawings in GRATELOUP (1840) the wing of *Strombus sublatissimus* lacks the typical stromboid notch. Therefore it stands closer to *Strombus fortisi* BRONGN. from the Northern Italian Eocene, as well as to *Strombus trigonus* GRAT. from the Oligocene and Aquitanian of France. Both species are considered to belong to the subgenus *Dilatilabrum* COSSMANN (COSSMANN & PEYROT 1923).

In its sculpture, the Oligocene *Strombus conoideus* GRAT. is reminiscent of the sculpture of subadult shells of *Strombus roegli,* but develops a quite different spire form with slightly keeled spire whorls. This feature was also mentioned by COSSMANN & PEYROT (1923) when they described *Strombus pelouatensis*. Finally, the Oligocene *Strombus fasciolarioides* GRAT. which also comes from the Adour Basin differs totally from *Strombus roegli* by its slender spindle-shaped and strongly sculptured shell.

In conclusion, the new *Strombus* differs from all other Oligocene strombids in its bulgy sutural shelf, the ventral swelling which may even exceed the spire, and in the extremely wide wing.

In the Early Miocene, the Genus *Strombus* in the Mediterranean-Atlantic region is represented only by the *Strombus (Lentigo) bonelli*-group. The various taxa of this group (*Str. pelouatensis* COSSM. & PEY., *Str. bonelli grateloupi* d'ORB., *Str. b. subcancellatus* GRAT., *Str. b. intermedia* SACCO, *Str. b. elongata* GRAT., *Str. b. mitroparva* SACCO, *Str. b. pseudoradix* (d'ORB.), *Str. b. mediocanaliculata* SACCO, *Str. b. crassecingulata* SACCO) differ markedly from *Strombus roegli*. Generally, their wings do never exceed the spire, the width/height ratio is considerably smaller and none of these taxa did ever attain the size of *Strombus roegli*.

Palaeohabitat

At all investigated sections, *Strombus roegli* is one of the most abundant molluscs, often occurring in large numbers in lensoid bodies. At Doutsiko, in particular, the very heavy shells form loose coquinas which wedge out within few meters. Similarly, in the Iranian section at Abadeh the casts of the shells are often concentrated close to coral patches. At Doutsiko, the shells are mainly associated with turbinids and *Cassis*; less frequently potamidids and the large sized naticid *Ampullinopsis crassatina* (LAM.) occur. A similar assemblage was observed within the strombid-bearing layers of Abadeh in Iran. The diverse Iranian gastropod fauna is characterised by the large strombids *Oostrombus irregularis* (FUCHS) and *Oostrombus auriculatus* (GRAT.). *Ampullinopsis crassatina*, cassiids and several turbinids are also frequent. The palecological analysis of these faunas in HARZHAUSER (2000) indicate very shallow marine, environments with sandy bottoms and scattered patch reefs in lagoonal settings, as the typical strombid palaeohabitat.

Palaeobiogeographic distribution and stratigraphic range

The species is documented from the early Chattian of both the Mesohellenic Basin in Greece and the Esfahan-Sirjan Basin in Central Iran. Two other Oligocene occurrences are of limited value. A poorly preserved cast of a giant, winged *Strombus* from the Oligocene of the Maltese Islands, on display in the Natural History Museum in Gozo, may represent *Strombus roegli.* This would be the westernmost distribution of the species. Towards south-east, another poorly preserved winged strombid, similar to *Strombus roegli,* is described and illustrated by AZZAROLI (1958) from Somalia. The cast derives from the "calcare coralligeno" at Bender Cassim which is probably of Late Oligocene age. Among Early Miocene deposits the species is only known from the Aquitanian of the Iranian Qom and Esfahan-Sirjan Basins. No occurrences younger than Aquitanian have been described in any of the investigated basins or in the literature.

The problem of an adequate sub-generic identification

The sub-generic subdivision of *Strombus* proposed by ABBOTT (1960), is still more or less accepted by most authors (cf. KREIPL & POPPE 1999). This approach, however, is somewhat problematic for palaeontologists, since some of the sub-genera are based on softbody anatomy. Hence, identification of fossil shells, and moreover of phylogentically very early ones, such as *Strombus roegli*, is difficult.

In comparison with modern sub-genera only *Tricornis* JOUSEAUME is reminiscent of *Strombus roegli* to some degree. A placement of *Strombus roegli* within *Tricornis* could be based on the smooth columella, the heavy shell and the tendency of Recent representatives to produce excessive wing structures. Additionally, gigantism is recorded especially within species assigned to *Tricornis*. Even the unusually shallow stromboid notch of *Strombus roegli* would not contradict the placement within *Tricornis*, since *Strombus (Tricornis) goliath* develops an even less significant notch.

However, comparisons with other Paleogene strombids show that the subgenus *Dilatilabrum* displays similarities in shell morphology as well. *Strombus (Dilatilabrum)*

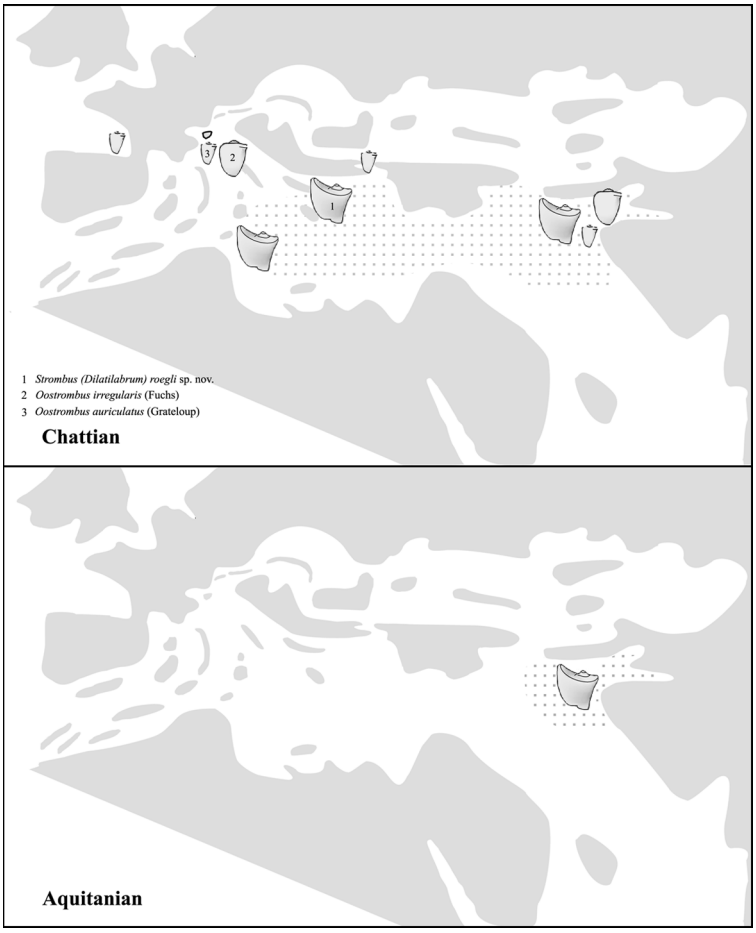


Fig. 2: Drastic reduction of distribution area of *Strombus roegli* from the Chattian to the Aquitanian. The "old-fashioned" Paleogene *Oostrombus irregularis* and *Oostrombus auriculatus* become extinct (in the investigation area) at least at the Oligocene/Miocene boundary. A distinct decrease in diversity of large-sized strombids can be observed. (Paleogeography based on Aquitanian-map after RÖGL 1998, modified)

fortisi BRONGN. from the Middle Eocene of N-Italy is very similar in wing structure, the deflected canal and the bulgy sutural shelf formed by the latest adult whorls (compare *Strombus (D.) fortisi* in SAVAZZI 1991: 322, BENEVENTI & PICCOLI 1969: pl. 1, WENZ 1940: 945, COSSMANN 1904: pl. 1). The main differences are only the smaller size and the absent stromboid notch. Consequently, *Strombus roegli* seems to unite features of the extinct subgenus *Dilatilabrum* with those of the extant *Tricornis*. Significantly, ABBOTT (1960) suggested *Strombus trigonus* GRAT. which is placed within *Dilatilabrum*, to be a forerunner of the *Tricornis* group. In contrast, SAVAZZI (pers. comm.) suggested that the development of the stromboid notch may have developed twice. The contemporaneous *Strombus radix* - representing the ancestor-group of the modern *Strombus* lineage - already shows a distinct stromboid notch. Therefore, the *Dilatilabrum* group seems to

have developed a similar morphological feature independently during the Oligocene. Future studies on the Eocene strombids will probably require a separation of *Dilatilabrum* as valid genus, which diverged from the *Strombus*-lineage very early. The mentioned similarities with *Strombus (Tricornis)* would therefore be only convergences.

Further it seems very likely that this step of strombid evolution happened within the Western Tethys Region. None of the Oligocene and Lower Miocene strombids of the Indo-Pacific mollusc faunas described by VREDENBURG (1925) stands close to this species. ABBOTT (1960) showed that the earliest *Tricornis*-related strombids of the Indo-Pacific derive from the Miocene of Java (see MARTIN 1891-1906), whilst *Dilatilabrum* is unknown at any time in the Indo-Pacific. Moreover, comparable strombids are probably missing in the Oligocene and Miocene faunas of the Caribbean and adjacent regions (DALL 1890, MAURY 1910. WOODRING 1928, GARDNER 1947).

Consequences for the interpretation of the Late Oligocene palaeoclimate

Stromboidea have proved to be excellent marker fossils for palaeoclimatic changes in Neogene. A well-known example is *Strombus (Lentigo) latus* GMEL. which evolved from the Miocene to Pliocene *Strombus (Lentigo) bonelli/coronatus* group, ubiquitous at that time throughout the entire Mediterranean. During the Pleistocene climatic deterioration, *Strombus latus* became extinct in the Mediterranean but found a refuge along the western coast of Africa. However, in the course of the Pleistocene climatic optima, *Strombus latus* managed to re-enter the Mediterranean Sea in short waves (CORNU & al. 1993, RÖGL & al. 1996/97). Similarly, *Aporrhais uttingerianus* (RISSO) experienced a drastic reduction of its distribution-area from the Middle Miocene to the Recent. The species was well established in the Mediterranean Sea during the Neogene but shifted its northern boundary to lower latitudes in the Quaternary and is restricted to the western coast of Africa today (SOLSONA & MARTINELL 2000).

Thus the temporal and geographic distribution of a striking species such as *Strombus roegli*, might yield important constraints on the climatic history of the Western Tethys. Among the modern strombids only *Strombus (Tricornis) gigas* LINN., *Strombus (Tricornis) latissimus* LINN. and *Strombus (Tricornis) goliath* SCHRÖT. regularly attain sizes comparable to those of *Strombus (Dilatilabrum) roegli* and all are warm-water dwellers of the tropical zone. Hence, *Strombus roegli* and probably also the co-occurring giant *Oostrombus irregularis* can confidently be interpreted as tropical species. The sudden occurrence and the remarkable abundance of *Strombus roegli* in the Chattian in the Eastern Mediterranean part of the Western Tethys may thus be correlated with a distinct warming trend. The fact that the species has never been recorded from Late Chattian or Aquitanian deposits in the Central Mediterranean and obviously had an earliest Lower Miocene refuge in the south-eastern Western Tethys (Qom Basin and Esfahan-Sirjan Basin) hints at a cooling trend in the Mediterranean area during the latest Oligocene. Moreover, the climatic conditions of the Aquitanian did not allow a re-immigration of *Strombus roegli* into the Mediterranean basins from its Iranian shelter. Even in its south-eastern refuge the animal became extinct by at least at the Aquitanian/Burdigalian boundary, since Burdigalian sections in the Iranian Qom Basin lack any evidence for large strombids. Instead, the characteristic Lower Miocene *Strombus (Lentigo) bonelli* BRONGN. exclusively represents the genus in the Central Iranian Burdigalian.

This scenario fits fairly well to the interpretation of Oligocene palaeoclimates by SPEZZAFERRI (1995, 1996) based on planktonic foraminifera, in which a palaeoclimatic trend within the Western Tethys shows a warming within the *Globigerina ciperoensis ciperoensis* Zone (P22). This warming trend was disrupted by a cooling towards the end of this zone. From the uppermost part of Zone P 22 to N4b (Latest Chattian to Aquitanian) the data indicate climatic instability, followed by stable and warmer conditions in the latest Aquitanian and Early Burdigalian (N5). Similarly, KELLER & al. (1992) proposed a significant global warming in the Early Chattian, from the evolution and diversification of surface dweller planktic foraminifera. Another indication for a "Mid-Oligocene" optimum is given by MCKINNEY & al. (1992), who deduce a peak in mean annual temperature in Mid-Oligocene times from the increase in echinoid diversity.

Acknowledgements

I would like to thank Prof. Dr. F. F. STEININGER (Senckenberg Museum, Frankfurt) who brought me in touch with the Greek and Iranian Oligocene molluscs. Thanks are also due to Dr. F. RÖGL (Museum of Natural History, Vienna) for his help in the field and for his valuable informations on planktic biostratigraphy. For reviewing this paper I want to thank Prof. Dr. E. SAVAZZI (University Uppsala) and Dr. M. ZUSCHIN (Institute for Palaeontology, Vienna).

Mag. A. LUKENEDER (Institute for Palaeontology, Vienna) kindly helped me with the preparation of the specimens and A. SCHUMACHER (Museum of Natural History, Vienna) took the photographs. This work was supported by the Fonds zur Förderung der wissenschaftlichen Forschung (P-11886 Geo) and by the "Deutsche Forschungsgemeinschaft" (grant STE 875/1-1).

References

ABBOTT, R. T. (1960): The genus *Strombus* in the Indo-Pacific. – Indo-Pacific Mollusca, **1**/2: 33-146.

AZZAROLI, A. (1958): L'Oligocene e il Miocene della Somalia. Stratigrafia, Tettonica, Paleontologia (Macroforaminiferi, Coralli, Molluschi). – Paleont. Ital., **57**: 1-143. – Pisa.

BENEVENTI, R. & PICCOLI, G. (1969): L'evoluzione del genere *Strombus* nel Paleogene delle Venezie. – Mem. Ist. Geol. Miner. Univ. Padova, **27**: 1-26. – Padova.

BRONGNIART, A. (1823): Mémoire sur les terrains de sédiment supérieur calcaréo-trappéens du Vicentin. – 1-86. – Paris.

CHAHIDA, M. R., PAPP, A., STEININGER, F. (1977): Fossilführung der Oligo/Miozänen Qum-Formation in Profilen bei Abegarm-Zefreh bei Isfahan (Zentraliran). – Beitr. Paläont. Österr., **2**: 79-93. – Wien.

CORNU, S., PÄTZOLD, J., BARD, E., MECO, J. & CUERDA-BARCELO, J. (1993): Paleotemperature of the last interglacial period based on $d^{18}O$ of *Strombus bubonius* from the western Mediterranean Sea. – PPP, **103**: 1-20. – Amsterdam.

COSSMANN, M. (1904): Essais du paléoconchologie comparée, **VI**: 1-151. – Paris.

—— & PEYROT, A. (1909-34): Conchologie néogenique de l'Aquitaine. – Act. Soc. Linnèe de Bordeaux, **63-86**. – Bordeaux.

DALL, W. H. (1890): Contributions to the Tertiary Fauna of Florida with especial reference to the Miocene Silex-Beds of Tampa. – Trans. Wagner Free Inst. Phil., **3**/1: 1-200. – Philadelphia.

GARDNER, J. (1947): The Molluscan Fauna of the Alum Bluff Group of Florida. Part VIII. Ctenobranchia (Remainder), Aspidobranchia, and Scaphopoda. – U.S. Geol. Surv., Prof. Pap. **142** H: 493-656. – Washington.

GRATELOUP, J. P. S. DE. (1840): Conchyliologie fossile des Terrains Tertiaires du Bassin de l'Adour. (Environs de Dax) - I, Univalves (Atlas): 1-27. – Bordeaux.

HARZHAUSER, M. (2000): Paleobiogeography and Palecology of Oligocene and lower Miocene Gastropods in the Eastern Mediterranean and the Westertn Indo-Pacific. – unpubl. PhD-Thesis, University Vienna: 284 pp. – Vienna.

KELLER, G., MACLEOD, N. & BARRERA, E. (1992): Eocene-Oligocene Faunal Turnover in Planktic Foraminifera, and Antarctic Glaciation. – In: PROTHERO, D. R. & BERGGREN, W. A. (eds.): Eocene-Oligocene Climatic and Biotic Evolution. – Princeton University Press: 218-244. – New Jersey.

KREIPL, K. & POPPE, G. T. (1999): A Conchological Iconography - The Family Strombidae. – 1-58. – Hackenheim (ConchBooks, formerly Christa Hemmen).

MARTIN, K. (1891-1906): Die Fossilien von Java auf Grund einer Sammlung von Dr. R. D. M. Verbeek. – Sammlungen des geologischen Reichs-Museums in Leiden, N. F. **1**: 1-332. – Leiden.

MAURY, C. J. (1910): New Oligocene shells from Florida. – Bull. Am. Paleontolgy, **4**: 119-164.

MCKINNEY, M. L., MCNAMARA, K. J., CARTER, B. D. & DONOVAN, S. K. (1992): Evolution of Paleogene Echinoids: A Global and Regional View. – In: PROTHERO, D. R. & BERGGREN, W. A. (eds.): Eocene-Oligocene Climatic and Biotic Evolution: 349-367. – New Jersey (Princeton University Press).

d'ORBIGNY, A. (1852): Prodrome de Paléontologie stratigraphique universelle des Animaux Mollusques et Rayonnés, **3**: 1-189. – Paris (Victor Masson).

RÖGL, F. (1998): Palaeogeographic Considerations for Mediterranean and Paratethys Seaways (Oligocene to Miocene) . – Ann. Naturhist. Mus. Wien, **99**/A: 279-310. – Wien.

—— , ANTL-WEISER, W., BRANDSTÄTTER, F., DERMITZAKIS, M. D., PAPESCH, W., PILLER, W. E., SCHULTZ, O., SYMEONIDES, N. K., TRIANTAPHYLLOU, M. V. & TSAPRALIS, V. (1996/97): Late Pleistocene marine cycles in Southern Corfu. – Ann. Géol. Pays Hellen., **37**: 663-767. – Athen.

SAVAZZI, E. (1991): Constructional morphology of strombid gastropods. – Lethaia, **24**: 311-331. – Oslo.

SCHUSTER, F. & WIELANDT, U. (1999): Oligocene and Early Miocene coral faunas from Iran: palaeoecology and palaeobiogeography. – Int. Journ. Earth Sciences, **88**/1999: 571-581.

SOLSONA, M. & MARTINELL, C. G. J. (2000): Patterns of change in the biogeographic distribution of Atlanto-Mediterranean Aporrhaidae (Gastropoda) from the Neogene to the Present. – PPP, **158**/2000: 83-97. – Amsterdam.

SPEZZAFERRI, S. (1995): Planktonic foraminiferal paleoclimatic implications across the Oligocene-Miocene transition in the oceanic record (Atlantic, Indian and South Pacific). – PPP, **114**/1995: 43-74. – Amsterdam.

—— (1996): Paleoclimatic interpretation of the late Oligocene-early Miocene planktonic foraminiferal record from the Lemme-Carrosio section (northern Italy). – Giornale di Geologia, (3) **58**/1-2: 119-139. – Bologna.

STEININGER, F. F., WIELANDT-SCHUSTER, U., SCHUSTER, F., PILLER, W. E., RÖGL, F., HARZHAUSER, M., MANDIC, O., KROH, A., REISINGER, J. & NEBELSICK, J. H. (in prep.): Stratigraphical and paleontological investigations in Oligocene and Early Miocene sedimentary sequences of the Mesohellenic Basin (NW Greece) – Abh. Senckenberg. Naturforsch. Ges.

VREDENBURG, E. (1925-28): Description of Mollusca from the Post - Eocene Tertiary formations of North - Western India. 1 and 2. – Mem. Geol. Survey India, **50+51**, 1-463. – Calcutta.

WENZ, W. (1938-1940): Handbuch der Paläozoologie. – Gastropoda. I-VI. – Berlin.

WOODRING, W. P. (1928): Miocene Mollusks from Bowden, Jamaica. – Part II. Gastropods and Discussion of Results. – Carnegie Inst. Wash., **385**: 1-564. – Washington.

Plate 1

Fig. 1: *Strombus (Dilatilabrum) roegli* sp. nov. - dorsal view
Holotype – Doutsiko, Greece - Chattian
Inv. NHMW 2000z137/0001 – 0.6 x

Plate 2

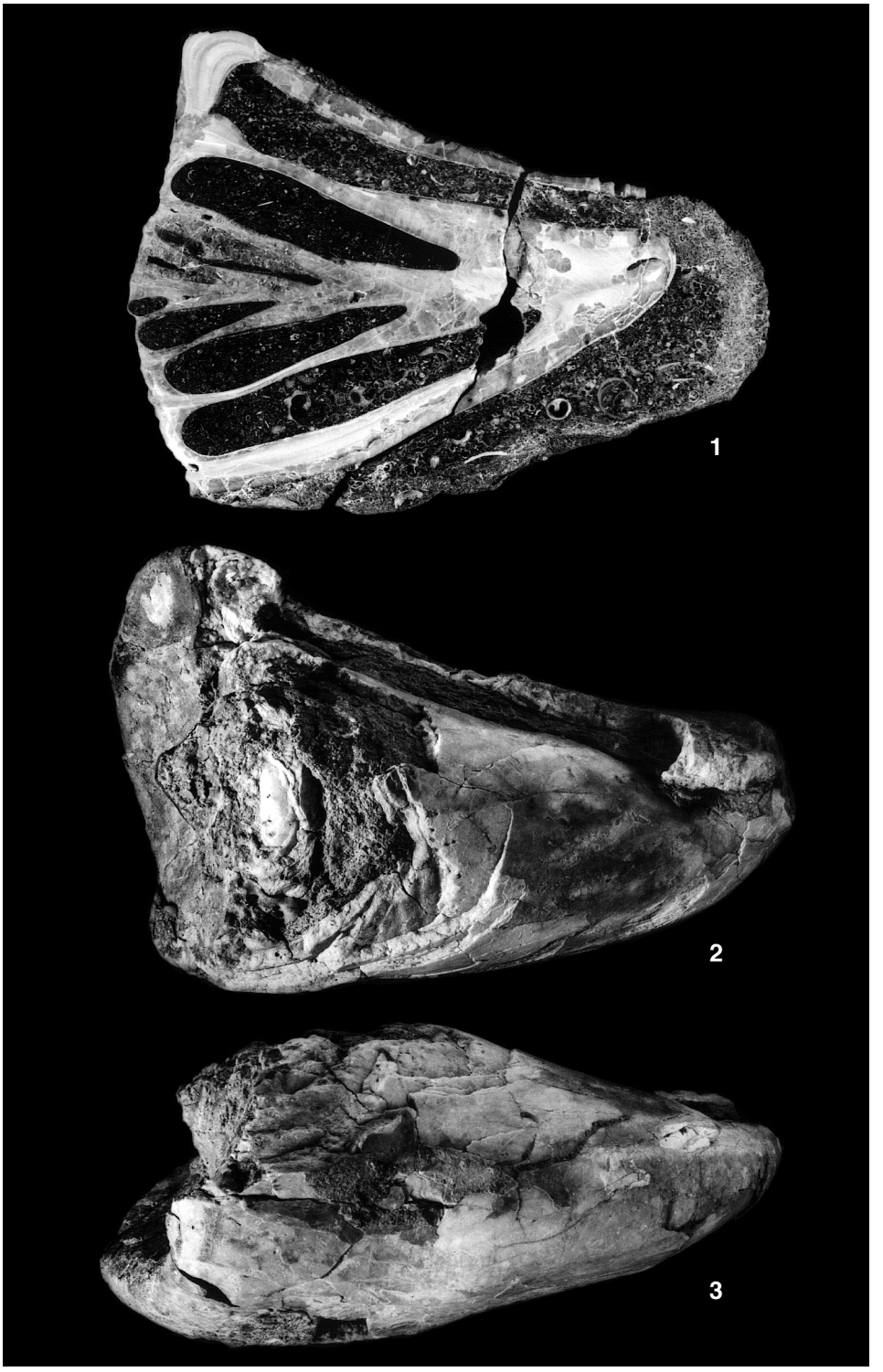
Fig. 1: *Strombus (Dilatilabrum) roegli* sp. nov. - ventral view
Doutsiko, Greece - Chattian
Inv. NHMW 2000z137/0002 – 0.6 x

Plate 3

Fig. 1: *Strombus (Dilatilabrum) roegli* sp. nov. – cross-section
Doutsiko, Greece - Chattian
Inv. NHMW 2000z 0162/0000 – 0.6 x

Fig. 2: *Strombus (Dilatilabrum) roegli* sp. nov. - lateral view
Doutsiko, Greece - Chattian
Inv. NHMW 2000z137/0005 – 0.6 x

Fig. 3: *Strombus (Dilatilabrum) roegli* sp. nov. - lateral view
Doutsiko, Greece - Chattian
Inv. NHMW 2000z137/0005 – 0.6 x


1
2
3