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PLIOCENE SCLERACTINIANS FROM ESTEPONA (MALAGA, SPAIN)

Abstract - V. SPADINI, *Pliocene scleractinians from Estepona (Malaga, Spain).*

Early Pliocene scleractinians from Estepona Basin (Spain) are described and illustrated. Twenty-seven species, belonging to the families Caryophylliidae (13 species), Dendrophylliidae (6 species), Flabellidae (5 species), Oculinidae (2 species) and Micrabaciidae and Turbinoliidae (one species each), were examined. The genus *Sphenotrochus* is reported for the first time from the Pliocene of the Mediterranean Sea. Other interesting findings include one species of *Bathelia* and one species of *Madrepora.*

Key words - Spain, Estepona, Pliocene, scleractinians

Riassunto - V. SPADINI, *Sclerattiniari pliocenici di Estepona (Malaga, Spagna).*

Vengono descritti e figurati gli sclerattiniari pliocenici provenienti dal bacino di Estepona (Spagna). Complessivamente le specie descritte sono 27 appartenenti alle famiglie Caryophylliidae (13 specie), Dendrophylliidae (6 specie), Flabellidae (5 specie), Oculinidae (2 specie) e, in ultimo, Micrabaciidae e Turbinoliidae (una specie). Un genere, *Sphenotrochus*, è citato per la prima volta nel Pliocene del Mar Mediterraneo. È confermata la presenza del genere *Bathelia*, già segnalata per il Pliocene senese e di una specie di *Madrepora*.

Parole chiave - Spagna, Estepona, Pliocene, Sclerattiniari

INTRODUCTION

This paper is the first account of the scleractinian fauna of the Pliocene Basin of Estepona and contributes to knowledge of the fossil fauna of the Iberian region. The Estepona Basin of southern Spain is characterized by fossiliferous outcrops of Pliocene age. The abundance and good preservation state of the faunal assemblage has enabled systematic and palaeoecological research on Pliocene benthic communities (Vera Paláez *et al*., 1995; Aguirre *et al*., 2005 and references therein; Landau *et al*., 2009 and references therein). These studies highlighted a rich macrofossil assemblage, with 1300 species of marine invertebrates, mainly molluscs together with echinides, brachiopods and scleractinian corals (Guerra Marchán *et al*., 1996; Aguirre *et al*., 2006).
Little is known about the scleractinian fauna of the Spanish Pliocene (Barrois & Offret, 1889; De Angelis, 1894; Castells, 1978). These papers reported on some species of scleractinians from Cataloña and describe a species from Andalusia. A total of 17 species of scleractinians are cited, two of which are proposed as new (*Astrocoenia almerai* De Angelis, 1894; *Flabellum malagense* Barrois & Offret, 1889). De Angelis (1894), also mentions species belonging to the genera *Caryophyllia*, *Dendrophyllia*, *Balanophyllia*, *Cladocora*, as many as four species of *Coenocyathus* and four of *Flabellum*, while Castells (1987) reports three species of *Flabellum* from Cataloña, all already reported by De Angelis (1894) (Tab. 1). Other undetermined species of the Spanish Pliocene have been figured by Martinell & Domenech (2009).
The scleractinian fauna described in the present paper appears interesting due to the finding of a species of the genus *Sphenotrochus*, never previously reported from the Pliocene of the Mediterranean Sea, a species of the genus *Bathelia* already reported from the Italian Pliocene (Spadini, 2016), and a species of *Madrepora.*

GEOLOGICAL SETTING

The Pliocene sediments in the Estepona basin rely on metamorphic rocks of the Sierra Bermeja and on sandstone of the Campo de Gibraltar Flysch Complex (Aguirre *et al.* 2005). The Pliocene deposits can be grouped in two sedimentary cycles (Guerra Merchán *et al*., 1996). The lower cycle consists of alluvial deposits in which littoral and shelf facies overlap. The upper cycle is represented by two units. The first is a thick debris facies, linked to the development of delta deposits and local coastal deposits. The second consists of bioturbated sandy and lutitic facies with abundant shallow-water marine faunal content (Guerra Merchán *et al*., 1996).
The specimens of scleractinian corals studied here come from three different outcrops of the Estepona Basin: Parque Antena, Valerín Carretera and Chincheta. The Parque Antena Section is one of the most diversified and rich paleontological sites in the Estepona Basin and is distinguished by the excellent state of preservation of its fossil fauna. (Guerra Marchan *et al*., 1996; Aguirre *et al*., 2005). The site extends for about 8 km ENE from Estepona. According to the paleogeographic re-

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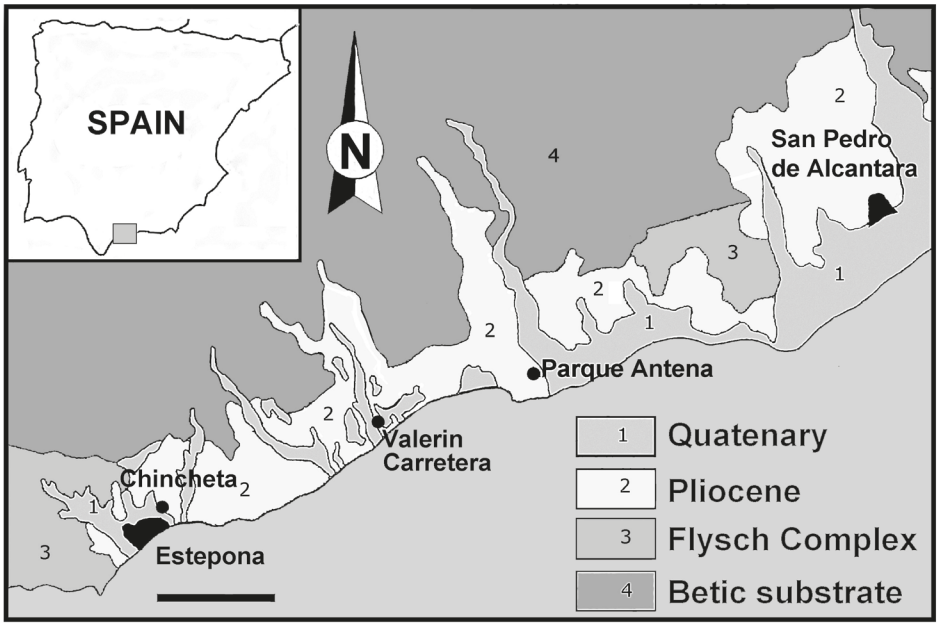

Figure 1. Schematic geological map of the study area indicating the geographical location of Parque Antena, Valerin Carretera and Chincheta (from Guerra-Merchán *et al*., 1999; modified).

construction, it is exposed along the coast and extends through the valley of the Rio Gualdalmansa (Aguirre *et al*., 2005). The sediment consists of coarse-grained sand intercalated with conglomerate and breccia. Fossil invertebrates are abundant in the conglomerates and sands deposited in the transition zone between the coastal strip and the shelf (Aguirre *et al*., 2005).

The Valerín Carretera deposit consists of medium to fine grained fossiliferous sands (bizcornil facies) very rich in fossils (Aguirre *et al*., 2005). The silts and fine grained sand of the lower part of the section coincide with the transition from the outer fan-delta to shelf settings.

The Parque Antena and Valerín-Carretera sections can be assigned to the late Zanclean (early Pliocene) on the basis of planktonic foraminifera (coexistence of *G. margaritae*, *G. puncticulata*, *G. crassaformis*). On the geochronological time scale, these deposits lie between the first occurrence of the *Globorotalia crassaformis* group (4.18 Ma) and the upper limit of Mediterranean Pliocene Molluscan Unit 1 (MPMU1) of Monegatti and Raffi (1983) (3,3-3,1 Ma) (Aguirre *et al*., 2005).

The Pliocene deposit of Chincheta consists of massive homogeneous fossiliferous medium to fine grained sand. Fossils are dispersed throughout the sand, although occasionally they are concentrated in thin beds (Brunetti Mauro, personal communication, 1/6/2019). The correlation of this site with Valerín Carretera is not known, but its proximity to the Valerín outcrop suggests an age and overall similarity with these Pliocene units.

By courtesy of MM Brunetti (Malaga, Spain), I was able to examine a small collection of scleractinians from these sites.

Materials and Methods

Coral fossil samples were collected manually and were cleaned and brushed with water and hydrogen peroxide to remove sediment. Identification was performed on the basis of macro and micromorphological characters related to corallum shape, development of radial elements, corallite diameter, number of pali and columella development according to Wells (1956), Zibrowius (1980), Cairns & Kitahara (2012) and Spadini (2015).

Observations were completed with optical equipment and the principal measurements were made with an analog caliper. Illustrations of the coralla and other details were made with a digital camera.

The systematic palaeontology of the specimens is presented in a family-genus systematic order. The characters of each species are described along with remarks on its classification.

The studied material is kept in the Museum of Natural Science, Accademia dei Fisiocritici, Siena (MUSNAF).

Abbreviation and acronyms

the following abbreviations are used in the text:

D = maximum calicular diameter;
d = minimum calicular diameter;
H = maximum height;
Sx = septa of cycle x (S_1, S_2 etc.);
Px = pali of cycle x (C_1, C_2 etc.);
MUSNAF: Museo di Storia Naturale dell'Accademia dei Fisiocritici, Siena;
IGF: Istituto di Geologia e Paleontologia, Firenze;

MNHN: Museum national d'Histoire naturelle, Paris; DSFTA: Dipartimento di Scienze Fisiche, della Terra e dell'Ambiente, Siena.

SYSTEMATIC PALAEONTOLOGY

Subclassis Hexacorallia Haeckel, 1866
Ordo Scleractinia Bourne, 1900
Familia Micrabaciidae Vaughan, 1905
Genus *Stephanophyllia* Michelin, 1841

Type species – *Fungia elegans* Bronn, 1837 by subsequent designation (Milne Edwards & Haime, 1848).

Remarks – In the European Neogene there are three species of *Stephanophyllia*: *S. elegans* Bronn, 1837, Mio-Pliocene, *S. imperialis* Michelin, 1841 only Pliocene, and *S. nysti* Milne Edwards & Haime, 1851, very similar to *S. imperialis*, widespread in the basins of northern Europe (Chevalier, 1961).

The distinction between the various species is very complicated and based on characters which are highly variable or of little taxonomic significance. Cairns (1989) regards *S. imperialis* and *S. nysti* as synonyms of *S. elegans*.

Stephanophyllia cf. *elegans* Bronn, 1837
Fig. 2

cf. *Fungia elegans* Bronn, 1837: 288, tav. 26, fig. 7.
cf. *Stephanophyllia elegans* – Milne Edwards & Haime, 1848: 93, tav. 1, figg. 10, 10a.
cf. *Stephanophyllia elegans* – Quenstedt, 1881: 1044, tav. 184, figg. 24-25.
cf. *Stephanophillia elegans* – Spadini, 2015: 33-36, figg. 11-15.

Type material – Lost (Chevalier, 1961).

Occurrence and material – Parque Antena (one specimen and fragments).

Description – Corallum large, cupulate, with calice diameter up to 31.2 mm and height 10.1 mm (h/D = 0.32). Flat base, costae irregular in centre of basal disc, alternating with rounded or carinated and depressed, distally dilated septa, generally larger than the intercostal spaces. Costal ornamentation variable, without granules or with one or more rows of irregular small granules in the distal part of costae.
Septa organised in typical micrabaciid fashion in five cycles, arranged hexamerally. S_1 are thin, straight, imperforate, proximally enlarged and non bifurcate. S_2 are equally thin, but proximally thicker. S_3 originates from S_2 and has multiple bifurcations in a well-defined sequence. These show clear fenestration of the septal margin (Spadini, 2015). Small marginal shelf sometimes present.
Straight regular columellar fossa. Columella lamellar, thin and straight, composed of aligned trabeculae.

Stratigraphic distribution – *S. elegans* was reported from the Middle Miocene of the Turin hills and Emilia (De Angelis, 1894; Montanaro, 1931); it was also reported from the Miocene of Baden and from some Paratethys localities by Reuss (1871). Common and widespread in the Italian Pliocene (Namias, 1891; De Angelis, 1894; Osasco, 1895; Simonelli, 1895; Spadini, 2015) and in the Pliocene of Rhodes (Zuffardi-Comerci, 1927).

Remarks – The specimen from Parque Antena differs significantly from those of the Siena Pliocene due to larger size, corallite robustness and the straight simple columella.
This specimen matches *S. stefaninii* Montanaro, 1931, described on a single specimen of the Pliocene of Bacedasco, known only from the type species. *S. stefaninii* is characterized by a narrow elongated columellar fossa and identical development of S_1 and S_2; it may be similar to *S. elegans* (Spadini, 2015).

Familia Oculinidae Gray, 1847
Genus *Bathelia* Moseley, 1881

Type species – *Bathelia candida* Moseley, 1881, by monotypy.

Diagnosis – Corallum arborescent, massive; calices disposed alternately in nearly straight rows on either side of several branches with very prominent margins. Coenenchym white, compact and dense, its surface being entirely covered by curved striae continuous with the costae. Calices deep and wide open with four cycles of septa, and a single crown of pali. Columella large, composed of numerous trabeculae (Moseley, 1881).

Remarks – The genus *Bathelia* is currently only represented by *B. candida* that lives in South America, from Rio Grande (Brazil) to Cabo Tres Puntas (Argentina), and off Peninsula Tres Montes (Chile) (Cairns & Polonio, 2013). Fossil specimens of undetermined *Bathelia* were reported in the northern hemisphere from La Gautrie (Loire, Atlantique) by Chevalier *et al.* (1989) (without description or figures) and by Spadini (2015, 2016) from the Pliocene of Siena.

Bathelia sp.
Fig. 3

Bathelia sp. – Spadini, 2016: 219-222.

Occurrence and material – Parque Antena and Chincheta (three fragments).

Description – Corallum colonial. Surface finely granular or costate near calice. Fossa shallow. Calice circular. Septa arranged regularly in four complete cycles and six systems making a total of 48 septa. There are three types of septa: dominant (S_1 and S_2), paliferous

(S_3) and secondary (S_4). S_1 and S_2 have smooth, straight axial edges, S_3 and S_4 have very thin, not always integral, axial edges. The septa of the first two cycles are equal in size and reach the columella in depth; S_3 are less exserted and bear a crown of pali that connect to the columella, and S_4 is smaller, close to dominant septa and generally more exserted than S_3. The margin of the pali is rarely straight, more often slightly sinuous, with large tubercles. The columella consists of an irregular group of slightly twisted elements.

Remarks – This fragmentary sample matches those previously studied from Siena (Spadini, 2015, 2016), but has a round rather than elliptical calice.

Genus *Madrepora* Linnaeus, 1758

Type species – *Madrepora oculata* Linnaeus 1758.

Diagnosis – Corallum colonial, extratentacular sympodial budding forming dendroid colonies. Coenosteum dense; costae absent. Pali absent; columella spongy or absent. Exclusively azooxanthellate.

Remarks – The genus *Madrepora* currently includes six species, of which *M. oculata* is cosmopolitan.
Numerous authors indicate different species of *Diplohelia* and *Amphihelia* from Miocene (De Angelis, 1894; Zuffardi-Comerci, 1932; Chevalier, 1961) and Pliocene deposits (Simonelli, 1895; Montanaro, 1931). Some of the species described by these authors can be attributed to *M. oculata* (Vertino, 2003; Zibrowius, 1980). *Madrepora* was reported from the middle Pliocene of northern Italy by Vertino *et al.* (2014) but occurrence of the genus in other Italian outcrops (e.g. Seguenza, 1864; 1880; De Angelis, 1894; Simonelli, 1895; 1896; Montanaro, 1931; Zuffardi, 1932; Chevalier, 1961) needs to be ascertained by further studies.

Madrepora cf. *oculata* Linnaeus, 1758
Fig. 4

Occurrence and material – Estepona, Chincheta (The material examined consists of small or medium-sized fragments of the basal part of a colony.)

Description – Corallum colonial. Surface smooth or with flat, wide, costae, separated by narrow well incised grooves. Near the calices, the costae of the coenosteum tend to be anastomosed into a typical polygonal form.
The corallites, of variable height, have a diameter of about 2-3 mm. Some calices are recessed into the coenosteum, from which the terminal part of the septa emerges in some cases.
The fossa is deeper in corallites of smaller branches, less deep in corallites of thicker proximal branches.
Septa are arranged hexamerally in three complete cycles, never fully preserved. They may protrude to different degrees with respect to the calice edge. S_1 are connected with the columella at the bottom of the calice, S_2 are sometimes free, S_3 are separate from the others. The axial margin of the septa is generally intact. Granulation is not very evident, but in some cases the granules are fine and sharp.
The columella is extremely variable, from rudimentary to very developed, and consists of a spongy mass.

Remarks – *Madrepora oculata* is a highly variable species. Both the extant and fossil specimens show extreme variability of the columella, septal granulation and the axial margin, even in the same colony (Vertino, 2003). The Estepona specimens seem to match the characteristics of the species, although the small amount of material did not permit accurate examination.
Seguenza (1864) described three species, two new (*A. miocenica* and *A. sculpta)*, under the generic name of *Amphihelia*. Other species related to *M. oculata* have been described by Seguenza (1864)under the genus *Diplohelia*: *D. meneghiniana*, *D. doderleniana*, *D. sismondiana*. According to Zibrowius (1989) they all refer to *Madrepora oculata*, but Vertino (2003) only includes *D. reflexa* Milne Edwards & Haime, 1848 and *D. meneghiniana*, in addition to the three *Amphihelia* species.

Stratigraphic distribution – Dell'Angelo *et al.* (2004) report a white coral layer in the Pliocene deposits of Rio del Padrón (Early Pliocene of Estepona Basin).
At least some of the Italian Mio-Pliocene findings attributed to *Amphihelia* and *Diplohelia* match *Madrepora*. Certain indications of *M. oculata* are from northern Italy (Vertino *et al*., 2014) and Plio-Pleistocene deposits around the Strait of Messina (Vertino, 2003).

Geographic distribution – *Madrepora oculata* is cosmopolitan in distribution (except Antarctic Seas), including the Atlantic Ocean and Mediterranean Sea (Cairns, 1979; Zibrowius, 1980), the sub-Antarctic (Cairns, 1982), Indian Ocean (Zibrowius, 1974), New Zealand (Squires & Keyes, 1967), Hawaiian Islands (Cairns, 1984), Galapagos (Marenzeller, 1904; Vaughan, 1906; Cairns, 1991) and Japan (Eguchi, 1968, Cairns, 1994).

Subordo CARYOPHYLLIINA Vaughan & Wells, 1943
Familia Caryophylliidae Dana, 1846
Genus *Caryophyllia* Lamarck, 1801

Type species – *Madrepora cyathus* Ellis & Solander, 1786, by subsequent designation (Broderip, 1828).

Diagnosis – Corallum solitary, turbinate, subcilindrical, ceratoid or trochoid, fixed or free. One crown of pali present before penultimate cycle of septa. Columella fascicular, composed of several twisted laths.

Remarks – The genus *Caryophyllia* consists of 66 Recent valid species. About fifteen species are currently

living in the eastern Atlantic (Cairns *et al*., 1999) and seven in the Mediterranean (Zibrowius, 1980). All representatives of this genus are solitary, with forms attached to the substrate (*Caryophyllia* s.s.), and others that detach at an early stage to continue a free life on soft bottoms(*Ceratocyathus* Seguenza, 1864).
In the Pliocene this genus is well represented (Seguenza, 1864; Simonelli, 1895, 1896; Osasco, 1895; Zuffardi-Comerci, 1932; Montanaro, 1931; Vertino, 2003).

Caryophyllia (*Caryophyllia*) *felsinea* Simonelli, 1895
Fig. 7

Caryophyllia felsinea Simonelli, 1895: 163, fig. 3, tav. 8, figg. 15-16.
Caryophyllia felsinea – Spadini, 2015: 48-49, figg. 32-40.

Type material – Type material from Ponticello di Savena in the Berti or Fornasini collections, presumably kept at the "G. Capellini" Museum of Bologna (Simonelli, 1896).

Material examined – Parque Antena (three specimens, one young, another incomplete).

Description – Corallum solitary, turbinate or subcylindrical, with corallite 15.2 mm tall and calice diameter 10.7 x 9.6 mm. Theca with 48 granular costae, equal or almost equally wide, separated by evident intercostals striae. In the distal part of corallites, the 12 costae, corresponding to the primary and secondary septa, are differentiated, equally developed, sometimes crested. Calice with 48 septa in four complete cycles and five systems. Fossa shallow. The septa of the first two cycles, S_1 and S_2, equal and more exserted than the others, S_3 paliferous and S_4 variable, sometimes equal or longer than S_3. Pali hardly discernible, arranged regularly before S_3.
Septa with small granules, dilated into lamellae towards the centre. The pali have much more evident lamellae.
Columella elongated, but poorly conserved, composed of a few twisted lamellae arranged in a single row.

Stratigraphic distribution – Pliocene: Emilia (Simonelli, 1896; Montanaro, 1931; Russo, 1980) Siena (Spadini, 2015), Rhodes (Zuffardi-Comerci, 1932).

Remarks – The Spanish specimens match the specimens of the Italian Pliocene (Spadini, 2015). Another species of the Italian Pliocene, *Caryophyllia calix* Sismonda, 1871, from the Pliocene of Albenga, seems very similar to *C. felsinea*.

Caryophyllia (*Caryophyllia*) *granulosa* De Angelis, 1894
Fig. 5

Type material – The type material from the Pliocene of Zinola has been lost. Chevalier (1961) erroneously reports that the type material was from the Middle Miocene of Serravalle Scrivia.

Occurrence and material – Chincheta (two specimen).

Description – Conical corallite with a rather narrow pedicel. Corallite 20.0 mm tall, calice diameter 14.5 x 13.1 mm, pedicel diameter about 3.2 mm. The outer surface of the corallite is entirely grainy, with costae of equal width, absent in the proximal part, more evident near the calice, separated by thin furrows.
Fossa relatively shallow. The calice is elliptical with 48 septa in four cycles and six systems. S_1 and S_2 equal, S_3 paliferous and S_4 adjacent S_1 equal or longer than S_3, while S_4 adjacent S_2 shorter than S_3. P_3 well separate from S_3, even shorter. Septal ornamentation consisting of granules, more or less expanded into lamellae, more evident in pali. Columella fasciculate with a few twisted lamellae.

Remarks – *Caryophyllia granulosa* can be confused with *C. clavus* Scacchi, 1835 (= *C. smithii* Stokes & Broderip, 1828), but is easily distinguished by the number of septa, constantly 48, by costal features and by the more circular calice. A character, namely grooves bored by *Sulcichnus*, reported by De Angelis (1894), can be observed in the specimen of Chincheta and in the specimens from the Pliocene of Siena (unpublished data).
According to Vertino (2003), *C. granulosa* is similar to *C. aradasiana* Seguenza, 1864 from the "Miocene" of Gravitelli and Tremonti, which in turn is equivalent to the living *C. calveri* Duncan, 1873 of the Mediterranean and the north-eastern Atlantic. *C. calveri* was long confused with *C. arcuata* Milne Edwards & Haime, 1848, never depicted and its type was lost (Zibrowius 1980). According to Chevalier (1961) *C. granulata* is very similar to *C. arcuata.*
The Siena specimens match the description of De Angelis (1894) and show differences in thecal ornamentation with respect to *C. calveri*, in which the granular character of the costae is not evident while the pali are clearly smaller than the septa (Zibrowius, 1980).

Caryophyllia (*Caryophyllia*) sp.
Fig. 6

Occurrence and material – Estepona, Chincheta (one specimen).

Description – Corallum subcylindrical, straight and attached by a slightly enlarged base. The examined specimen is 12.3 mm tall and 7.7 x 6.6 mm in calice diameter with 4.3 mm of attached base. Theca thick, with 48 flat granulose costae, more evident near calice edge, and separated by narrow shallow intercostal striae. Costae usually bear very small, rounded granules: three or four occurring across the width of a costa. Fossa moderately deep, calice elliptical with 48 septa arranged hexamerally in four complete cycles. The radial elements are not well conserved. S_1, merged with the columella, are more developed than S_2. S_3 palife-

rous and S_4 very reduced. Pali with enlarged granules. Columella trabecular, composed of an irregular group of slightly twisted elements.

Caryophyllia (*Ceratocyathus*) *simplex* Seguenza, 1864
Fig. 8

Type material – The type material, kept in the Seguenza collection, was destroyed during the Messina earthquake of 1908.

Occurrence and material – Parque Antena (two complete specimens).

Description – Corallum monocyclic, not reinforced, free, 14.4 mm tall and with calice diameter 14.8 x 11.3 mm. Outer surface with slight granulation. Costae barely marked by thin furrows, those on S_1 and S_2 more evident near calice.
Calice slightly elliptical with 48 septa arranged regularly in four complete cycles with hexameral symmetry and twelve apparently equal systems. Thin septa, S_1 same as S_2; S_3 paliferous, S_4 very thin. P_3 strong, slightly twisted, well separated from S_3 and as wide as the septum with pointed tubercles. Columella simple, composed of a few twisted merged laminar elements.

Stratigraphic distribution – "Miocene" of Gravitelli (Seguenza, 1864, 1880), Early Pliocene of Siena (Spadini, 2015).

Remarks – The specimens of the Spanish Pliocene differ from those of Siena (Spadini, 2015) displaying a more regularly elliptical calice, but are in line with the diagnosis of Seguenza (1864).

Genus *Ceratotrochus* Milne Edwards & Haime, 1848

Type species – *Turbinolia multiserialis* Michelotti, 1838 by original designation (Milne Edwards & Haime, 1850).

Diagnosis – Corallum trochoid or ceratoid, solitary. Pali absent. Paliform lobes present or absent, columella large and papillose. Costal spines generally present.

Remarks – Three species are currently attributed to this genus: *C. franciscana* Durham & Barnard, 1952 of the eastern Pacific, *C. magnaghi* Cecchini, 1914 of the Mediterranean and *C. laxus* Vaughan, 1907.

Turbinolia duodecimcostata Goldfuss, 1826 and related species were separated from *Ceratotrochus* s.s. and placed in the subgenus *Edwardsotrochus* Chevalier, 1961 (type species *Turbinolia duodecimcostata* Goldfuss, 1826 by original designation). *Edwardsotrochus* is currently extinct. It is distinguished from *Ceratotrochus* s.s. by virtue of its size, its columellar features, the absence of spines or tubercles and vertical paliform lobes, and the development and arrangement of its septa.

Ceratotrochus (*Ceratotrochus*) *multispinosus* Michelotti, 1838
Fig. 9

Turbinolia multispina Michelotti, 1838: 71, tav. 2, fig. 7.
Ceratotrochus multispinosus – Chevalier, 1961: 354-355, figg. 121-123.

Type material – Lost (Chevalier, 1961).

Occurrence and material – Parque Antena (one specimen); Chincheta (one specimen).

Description – Corallum of trochoid shape. Calice circular with 48 septa. The specimen of Parque Antena is characterized by costae partially covered by epitheca and ornamentation consisting of spines or tubercles, rather reduced, but present on C_1, C_2 and C_3. The specimen of Chincheta only has tubercles on C_1 and C_2, evident near the calice.
Paliform lobes absent or not preserved. Columella consisting of vertical elements not well conserved.
Stratigraphic distribution – Miocene of many localities in Italy and Paratethys (Chevalier, 1961), Pliocene of Piedmont, Liguria, Emilia and Tuscany (Osasco, 1895; Simonelli, 1895, 1896; Montanaro, 1931; Spadini, 2015).

Remarks – This species features 12 spiny costae and 48 septa. It differs from *C. multiserialis* Michelotti, 1838 which generally has more spiny costae and fewer septa. Morphotypes with intermediate features make classification of these scleractinians particularly difficult and uncertain.

Ceratotrochus (*Ceratotrochus*) sp.
Figg. 10, 15

Trochocyathus sp. – Martinell & Domènech, 2009, figg. 4 A, B, C1, C2.

Occurrence and material – Parque Antena (29 specimens), Chincheta (3 specimens).

Description – Corallum ceratoid, devoid of spines or tubercles, covered by a more or less incomplete, thick, smooth and/or shiny epitheca, which sometimes reveals finely granular costae. Fossa shallow, calice regularly circular. Maximum calice diameter 8.5 mm and maximum height of corallite 15.0 mm. Septa regularly arranged in four complete cycles and six systems for a total of 48 septa. S_1 more exserted than S_2 and S_3; S_4 small and poorly exserted.
Septa S_1 reach the columella, S_2 and S_3 are subequal, slightly shorter than S_1. S_4 are more slender and about half the width of S_1. The inner margin of the septa is straight with the exception of S_4 which are slightly wavy. Septal faces with fairly accentuated granules.
In regular specimens, paliform lobes precede the septa of the first three cycles. Those before S_1 are simple, those before S_2-S_3 are fused into laminar structures.

The columella is composed of vertical elements similar to simple paliform lobes.

Remarks – This species is easily identified by its smooth theca covered with an incomplete epitheca. Some features are quite variable, for example corallite shape (ceratoid to trochoid), epithecal development and how the septa insert into the theca. In addition, numerous specimens differ by having paliform lobes arranged in a less regular way, or even absent or not distinguishable from columellar papillae.
Among the various species and varieties of *Ceratotrochus* without ornamentation or with reduced ornamentation, the specimens from the Pliocene of Estepona may be similar to *C. multiserialis* var. *mutica* (Montanaro, 1929) from the Tortonian of Montegibbio, characterized by four complete cycles of septa, reduced ornamentation and a thick but incomplete epitheca that partly covers the costal ornamentation. Direct comparison is necessary.
The theca of some specimens shows grooves bored by *Sulcichnus sigillum* (Martinell & Domenech, 2009).

Ceratotrochus (*Edwardsotrochus*) *duodecimcostatus*
Goldfuss, 1826
Fig. 11, 12

Turbinolia duodecim-costata Goldfuss, 1826: 52, tav. 15, fig. 6.
Ceratotrochus duodecimcostatus – Milne Ewards & Haime, 1848: 250-251.
Ceratotrochus duodecimcostatus – Osasco, 1895: 229-230, fig. 4.
Ceratotrochus duodecimcostatus – Spadini, 2015: 61-64, figg. 64-76.

Type material – Lost (Chevalier, 1961).

Occurrence and material – Chincheta and Parque Antena (two specimens and numerous proximal fragments).

Description – Corallum trochoid of medium size. Largest specimens 20.6 mm tall with calice diameter 22.2 x 13.5 mm. Theca generally with 96 costae, more evident in the first two cycles of septa, in particular in the distal part of the corallite.
Calice elliptical, 96 septa in five complete cycles. Fossa deep. The septa of the first two cycles (S_1 and S_2) are identical, very exserted at calice margin and reaching the columella. S_3 are less exserted, but also reach the columella. S_4 merge at the columella at the bottom of the calice, S_5, adjacent the dominant septa (S_1 and S_2), are slightly more exserted than S_4 with which they are fused (Spadini, 2015). Columella composed of numerous anastomosed lobes.

Remarks – The largest specimen shows good correspondence with the Siena specimens and with Italian Pliocene specimens in general. Other small incomplete specimens, trochoid to ceratoid, vary widely in curvature of corallite and number of septa.

Ceratotrochus (*Edwardsotrochus*) sp.
Fig. 13

Occurrence and material – (one complete specimen, others without calice).

Description – Corallum ceratoid of medium size, curving in a plane oblique to the major axis. Largest specimens 16.3 mm tall, calice diameter 12.5 x 9.4 mm. Theca with poorly defined costae, evident only in the distal part of the corallite. There are 80 septa arranged in five cycles and ten systems with pentameral symmetry. The septa of the first two cycles (S_1 and S_2) are identical, very exserted on calice margin and reaching the columella. S_3 are less exserted but also reach the columella. S_4 merge at columella at bottom of calice; S_5, adjacent to dominant septa (S_1 and S_2), are slightly more exserted than S_4 with which they are fused. Fossa very deep, well developed fasciculate columella.

Remarks – This species is rather variable. Among the various species with pentameral symmetry (*C. marocensis* Chevalier, 1962 and *C. incertus* Zuffardi-Comerci, 1932 with ceratoid corallite and *C. pentaradiatus* Chevalier, 1961 with trochoid corallite), the specimens from the Pliocene of Estepona are similar to *C. bellingherianus* (Michelin 1841) in terms of the general ceratoid to trochoid shape of the corallite.

Genus *Coenocyathus* Milne Edwards & Haime, 1848

Type species – *Coenocyathus cylindricus* Milne Edwards & Haime, 1848, by subsequent designation (Milne Edwards & Haime 1850).

Diagnosis – Colonial, corallites usually bud extratentacularly from a common thick basal coenosteum, occasionally from lateral edges of other corallites and rarely intratentacularly. Corallites cylindrical and usually stout, with no anastomosis. Septotheca costate and granular.
Septa in 3 or 4 cycles of variable symmetry. Crown of well-formed pali precedes penultimate septa1 cycle. Columella papillose or fascicular (twisted elements). Endotheca absent (Cairns, 2000).

Remarks – Seven species are currently assigned to this genus, but *Coenocyathus anthophyllites*, currently living in the Mediterranean Sea, is excluded from *Coenocyathus* by Cairns (2000) on the basis of morphological characters.
Various Miocene or Pliocene species have been attributed to the genus *Coenocyathus* (Duncan, 1865; Michelotti, 1871; Reuss, 1871; Chevalier, 1961, 1962). According to Zibrowius (1980), these attributions are rather doubtful.

Coenocyathus cylindricus sensu De Angelis, 1894

Coenocyathus cylindricus – De Angelis, 1894: 18, fig. 15.

Material – Chincheta (some very incomplete colonies).
Description – Corallum colonial. Colonies composed of numerous cylindrical corallites, irregularly arranged, with granular surface and costae visible only near calice.
Septa incomplete, numbering 48 in the largest corallites in four cycles and six systems. Trace of trabecular columella, never complete.

Remarks – The material from the Spanish Pliocene, always very incomplete, does not allow a complete appraisal of the features of this species. We only note a similarity with Fig. 15 of De Angelis (1894).
De Angelis (1894) lists four species of *Coenocyathus* from the Spanish Pliocene: *C. corsicus* Milne Edwards & Haime, 1848, *C. antophyllites* Milne Edwards & Haime, 1848. *C. cylindricus* Milne Edwards & Haime, 1848 and *C. affinis* De Angelis, 1894.

Coenocyathus corsicus sensu De Angelis, 1894 from the Pliocene of Catalonia is not the same as the current species described by this name, which is synonymous with *Pourtalosmilia antophyllites*.
According to Zibrowius (1980), the specimens described and figured by De Angelis (1894) as *C. cylindricus* do not belong to this species, while those attributed to *C. antophyllites* belong to an indeterminate species of *Caryophyllia*.

Genus *Aulocyathus* Marenzeller, 1904

Type Species – *Aulocyathus juvenescens* Marenzeller, 1904 by monotypy.

Diagnosis – Corallum solitary, ceratoid, free. Most coralla show evidence of budding from a fragment of a parental corallum; costae poorly defined; upper and outer edges of septa join theca below upper thecal edge, usually forming trough around calice. Paliform lobes occasionally present; columella trabecular (Cairns, 1995).

Remarks – The genus *Aulocyathus* comprises four species: *A. recidivus* Dennant, 1906 and *A. juvenescens* (Kent, 1871) of the Indo-West Pacific, *A. atlanticus* Zibrowius, 1980 of the eastern Atlantic, *A. matricidus* (Kent, 1871) of Japan.
Aulocyathus atlanticus Zibrowius, 1980 is considered to be a synonym of *Conotrochus typus* Seguenza, 1864 by Vertino (2003).

Aulocyathus cf. *atlanticus* Zibrowius, 1980
Fig. 17, 18

Occurrence and material – Parque Antena (three specimens).

Description – Corallum solitary, elongated, cylindrical to ceratoid, that bud from a fragment of a parent corallum. Maximum calice diameter 6.3 mm, height of corallite 15.6 mm. Theca smooth, costae covered in a thin layer of epitheca, with very weakly developed costae, separated by slight intercostal furrows and bearing very low granules.
Calice rim smooth or serrated. Calice circular with 34-40 septa disposed in four incomplete cycles with hexameral symmetry. Septa non-exserted. Very deep fossa with rudimentary trabecular columella, consisting of short paliform lobes originating from dominant septa.
Geographic distribution – Southern sector of Bay of Biscay, Atlantic coast of the Iberian Peninsula, Azores, Madeira and Morocco (Zibrowius, 1980). Recently collected from Galicia Bank (Altuna, 2013). All records from Bay of Biscay are from a bathymetric range of 575-900 m.

Remarks – Three specimens with different characteristics presumably belong to the same species. Those from the Pliocene of Estepona are very similar to those from the Atlantic Ocean figured by Altuna & Rios (2014) but they generally lack of the columella.
Vertino (2003) established that *Aulocyathus atlanticus* Zibrowius, 1980 is a synonym of *Conotrochus typus* Seguenza, 1864. However, the specimens from the Spanish Pliocene seem different from the *C. typus* in the Seguenza collection kept at the IGF. The differences are very reduced dimensions, theca smooth or with slightly developed costae and columella generally rudimentary.

Genus *Paracyathus* Milne Edwards & Haime, 1848

Type species – *Paracyathus procumbens* Milne Edwards & Haime, 1848 by subsequent designation(Milne Edwards & Haime, 1850).

Diagnosis – Corallum solitary, turbinate or cylindrical, fixed or free. Pali or paliform lobes precede all but last cycle. Columella well developed, papillose, often indistinguishable from inner paliform lobes.

Remarks – The genus *Paracyathus* includes 22 currently living species, distributed mostly in tropical or subtropical seas (Cairns *et al*., 1999). Two of them, *Paracyathus arcuatus* Lindström, 1877 and *Paracyathus pulchellus* (Philippi, 1842), currently live in the eastern Atlantic and Mediterranean (Zibrowius, 1980).
In the Pliocene there were *P. pedemontanus* Michelin 1841 (De Angelis, 1894, Osasco, 1895, Simonelli, 1896, Montanaro, 1929, Zuffardi-Comerci, 1932, Spadini, 2015) and *P. striatus* (Seguenza, 1880). The latter seems similar to *P. pulchellus*.

Paracyathus sp.
Fig. 14

Occurrence and material – Chincheta (two specimens), Parque Antena (one incomplete specimen).

Remarks – The poor condition of the material does not allow rigorous determination, even to generic level. The specimens are provisionally assigned to the genus *Paracyathus*, although corallites covered by a thick epitheca also suggest similarity with *Tethocyathus* or *Trochocyathus*.

Genus *Trochocyathus* Milne Edwards & Haime, 1848

Type species – *Turbinolia mitrata* Goldfuss, 1826 by subsequent designation (Milne Edwards & Haime, 1850). (*T. plicata* according to Alloiteau, 1952).

Diagnosis – Corallum solitary, turbinate, ceratoid or trochoid, fixed or free. Pali arranged in two distinct crowns precede all but the last cycle. Columella fascicular or spongy.

Remarks – *Trochocyathus* includes more than 30 living species (Cairns *et al*., 1999), one of which lives in the Mediterranean Sea (Zibrowius, 1980).
Fossil species of *Trochocyathus* s.s are numerous. About 27 species have been described from the Neogene of the peri-Mediterranean. Twenty species are exclusively Miocene and seven are from the Pliocene.

Trochocyathus sp.
Fig. 16

Occurrence and material – Parque Antena (11 specimens)

Occurrence and material – Corallum of medium size, free, with wide flat or slightly convex irregularly bowl-shaped circular or slightly ovate base.
The base is smooth and in some cases shows a juvenile theca, but is generally covered by many layers of non-granulated tectura.
Wide, rounded costae with scattered granules are separated by deep intercostal furrows that become wider towards the periphery.
Fossa shallow. Circular or slightly elliptical calice. Maximum calice diameter 18.0 mm, height of corallite 17.2 mm. There are 48 septa in four complete cycles, disposed with hexameral symmetry. Pali precede all but the last cycle. S_1 thick, merged with columella; S_2 thinner than S_1, also merged with columella; S_3 shorter, connected to S_2. S_4 adjacent S_1 are slightly more exerted and wider than those adjacent S_2. Pali arranged in two crowns, one innermost (P_1, P_2), the other outermost (P_3), as is typical of *Trochocyathus* (Fig. X). P_{1-2} are longer than P_3.
Elongated columella containing a small number of cylindrical or irregular flattened papillae, fused among themselves and with inner edge of P_{1-2}.

Remarks – The species here described is a typical *Trochocyathus* with 48 septa arranged in four complete cycles and six systems, but is characterized by the massive presence of layers of tectura that cover the corallite base.
Some specimens show grooves of *Sulcichnus* sp. around the corallite base.

Genus *Pourtalosmilia* Duncan, 1884

Type species – *Madrepora anthophyllites* Ellis & Solander, 1786.

Diagnosis – Corallum colonial with conical or subcylindrical corallites and four cycles of septa. Columella well developed, spongy or with distinct lobes, one crown of distinct pali opposite S_3, abundant endothecal dissepiments.

Remarks – This genus includes two extant species: *Pourtalosmilia anthophyllites* (Ellis & Solander, 1786), also present in the Mediterranean, and *P. conferta* Cairns, 1978 from the Gulf of Mexico.

Pourtalosmilia sp.

? *Pourtalosmilia* sp. – Spadini, 2015: 87-88, figg: 113-114.

Occurrence and material – Chincheta (one specimen).

Description – Cylindrical corallite, 17.9 mm tall and about 10.6 x 9.4 mm in diameter, from base of which another corallite, 3.8 mm in diameter, detaches. Surface covered in evident dense granulations with thin furrows delimiting regular costae, more evident near calice. Calice elliptical with identical septa of the first two cycles, protruding slightly from edge of calice. Septa relatively undeveloped, or not integral, arranged in four complete cycles and six systems. All septa are irregularly covered in rudimentary granules. Deep fossa, trabecular columella poorly developed.

Remarks – The only entire specimen of *Pourtalosmilia* sp. differs substantially from those of the Pliocene of Siena (Spadini, 2015) due to lack of a crown of pali. This may be due to the poor conservation of the elements of the calice.

Familia Turbinolidae Milne Edwards & Haime, 1848
Genus *Sphenotrochus* Milne Edwards & Haime, 1848

Type species – *Turbinolia crispa* Lamarck, 1816, by subsequent designation (Milne Edwards & Haime, 1850).

Diagnosis – Corallum cuneiform with rounded base and elliptical calice. Costae smooth or granular and continuous from calice to base or fragmented into short parallel ridges. Septa in three or four cycles. Pali and paliform lobes absent; columella lamellar.

Remarks – *Sphenotrochus* is a genus of scleractinian coral belonging to the family Turbinoliidae (Milne Edwards & Haime, 1848). This genus includes approximately 34 valid species including 25 that are exclu-

sively known as fossils. The extinct species are restricted to the Eocene to Miocene of Europe, but four are known from the Miocene of the western Pacific and six from the Eocene to Miocene of the Caribbean and eastern United States (Cairns, 2003).
Recent species are widespread in the Pacific, South Africa, the Mediterranean and the Atlantic Ocean (Cairns, 1997). *Sphenotrochus andrewianus* Milne Edwards & Haime, 1848 currently lives in the Mediterranean Sea (Zibrowius, 1980).
Chaix *et al.* (1999) suggested that *S. intermedius*, *S. milletianus* Defrance, 1828 and *S. andrewianus* Milne Edwards & Haime, 1848 are a single species with a large geographic and stratigraphic distribution, from the Oligocene to the present.

Sphenotrochus intermedius Munster in Goldfuss, 1829
Fig. 20

Occurrence and material – Chincheta (one specimen).

Description – Corallum solitary, small, cuneiform, laterally compressed, having slightly convex thecal faces, rounded thecal edges and an acutely angled base. Calice diameter 3.58 x 2.14 mm, height of corallite 4.91 mm. Costae prominent, well separated, some converging in the lower part of corallum. Fossa very shallow. Calice regularly elliptical. There are 24 septa, arranged hexamerally in three complete cycles. S_1 and S_2 are exserted and fuse not far down into the fossa. S_3 are less exserted and seem separate from columella. Pali absent. Columella lamellar, 1.24 mm, forming single lamella in line with long axis of the calice.
Stratigraphic and geographic distribution – According to Chaix *et al.* (1999), *S. intermedius* includes all the following forms, which are in fact synonymous:
– *Sphenotrochus intermedius.* From Oligocene to Pliocene of North Sea (England, Germany, The Netherlands etc.) and eastern Atlantic (Aquitaine, Loire Basin);
– *S. milletianus*. From Miocene to Redonian of eastern Atlantic;
– *S. andrewianus.* From Pleistocene to Holocene of eastern Atlantic (Great Britain, Azores and Senegal) and Mediterranean Sea at depths of 12-150 m. The subspecies *S. a. moorei* is distributed in the western Atlantic from North Carolina to Florida at depths of 9-42 m (Cairns, 2000).

Habitat – *S. andrewianus*, which is morphologically very similar to *S. intermedius*, lives interstitially in coarse sand or shell gravel from shallow sublittoral zone down to at least 100 m (Zibrowius, 1980).

Remarks – The specimens described are very similar to *S. intermedius*, but also to specimens of *S. andrewianus* from the Mediterranean Pliocene. According to Zibrowius (1980), the criteria on which their distinction is based are highly uncertain.

The only mention of fossil scleractinians of the genus *Sphenotrochus* from the Mediterranean basin is by De Angelis (1893) who reported *S. intermedius* in the Pleistocene sands of Monte Mario.
Chevalier (1961) described the new species *Sphenotrochus cestasensis* from the French Burdigalian: it differs from *F. intermedius* due to thicker and more sinuous costae.
This is the first finding of the genus *Sphenotrochus* from the Mediterranean Pliocene.

Familia Flabellidae Bourne, 1905
Genus *Flabellum* Lesson, 1831

Type species – *Flabellum pavoninum* Lesson, 1831, by monotypy.

Diagnosis – Corallum solitary, free, flabellate, cuneiform or trochoid. Base not reinforced. Calice edge smooth or jagged. Septa numerous disposed in 4-7 septal cycles. Fossa deep. Columella rudimentary, a simple fusion of inner edges of major septa. Pali, dissepiments and sinapticules absent. Azooxanthellate.

Remarks – The genus *Flabellum* is divided into two subgenera: *Flabellum* s.s. and *F. (Ulocyathus)*, based on the shape of the calice edge.
Several species of *Flabellum* have been reported from the Spanish Pliocene: *F. avicula* Michelotti, 1838; *F. intermedium* (Michelin, 1841); *F. distinctum* ME & H., 1848 (= *F. extensum* ME&H, 1848); *Flabellum michelini* ME & H., 1848 and *F. malagense* Barrois & Offret, 1889 (De Angelis 1894; Barrois & Offret, 1889; Castells, 1978).

Flabellum cf. *asperum* Milne Edwards & Haime, 1848
Fig. 21, 22

Type material – The neotype from the Miocene of Tortona in MNHN, Paris (specimen MNHN.F. R10643).

Occurrence and material – Parque Antena (23 specimens), Chincheta (5 specimens).

Description – Corallum solitary, compressed, with short peduncle and straight lateral margins. Basal angle 24-70° and lateral or compression faces inclined about 17°.
Calice regularly arched with whole margins and regularly rounded edge of the calice. Maximum calice diameters 16.4 x 8.5 mm (d/D = 0.51) and height of corallite 27.9 mm. Clearly evident crests near the main septa of the first cycle. Lateral faces completely smooth with a very thin layer of glossy tectura.
Eighty to 90 septa arranged in five incomplete cycles and what appear to be 10-12 systems. S_1 and S_2 are identical, S_3 slightly thinner, all equally thick at axial margin. S_4 have wavy axial margin and S_5 are very thin with straight axial margin.

Granulation of septa apparently uniform with small pointed granules, probably arranged in trabecular rows.

Remarks – The specimens show a remarkable resemblance to the type figured by Chevalier (1961). *Flabellum michelini* has very similar corallite but a straight (not arched) calice and lacks lateral crests on main septa of first cycle.

Flabellum cf. *intermedium* M.-Edwards & Haime, 1848
Fig. 27

Flabellum intermedium – Chevalier, 1961:395-396, text-fig. 135k.

Typematerial – Lost.

Occurrence and material – Parque Antena, Valerian Carretera (numerous incomplete specimens).

Description – Corallum of medium size, flabelloid, very compressed. Basal angle 85-95° and lateral or compression faces inclined about 20°.
An incomplete specimen from Valerín-Carretera is 23.8 mm tall with calice diameter of 26.7 x 9.2 mm (d/D = 0.34). Lateral thecal crests develop in proximal part of corallite; lateral edge rounded in distal part of corallite without evidence of crests or ridges. Thecal faces slightly convex, irregularly corrugated, with rare transverse chevron-shaped growth lines and very inconspicuous costae. Fossa not very deep. More than 120-130 septa arranged hexamerally in six incomplete cycles, but calice is always incomplete. Columella formed by the lower edge of S1-4.

Remarks – The specimens of *F. intermedium* are always incomplete, so it is not possible to determine all the characters of the calice.
Flabellum intermedium is very similar to *F. extensum*, but distinguished by a smaller basal angle, angular calice extremities and crested primary septa.

Flabellum malagense Barrois & Offret, 1886
Figg. 22-25

Flabellum malagense Barrois & Offret, 1886: 280-281, fig. 12.

Type material – Unknown.

Occurrence and material – Chincheta (two incomplete specimens), Valerín-Carretera (one specimen).

Description – Corallum solitary, slightly compressed, with short peduncle and slightly convex lateral margins. Basal edge angle about 80-90° and inclination of lateral faces 61-73°.
The specimen illustrated is 18.8 mm tall with elliptical calice and diameters of 16.2 x 12.4 mm (d/D = 0.76). Thecal faces convex with transverse chevron-shaped growth lines. Well-pronounced ridges appear at about S_1, less evident at S_2. Septa in four cycles, but in the complete corallite there are also some fifth cycle septa. Septal faces with granules in trabecular rows, inner edge of septa rounded, not thickened, S_4 and S_5 sometimes wavy. Fossa deep. Pseudocolumella elongated, subspongiose. The corallites illustrated show a groove of *Sulcichnus.*

Remarks – The complete analysed specimen matches *F. malagense* well. This *Flabellum* species has four cycles of septa; the other features are within the variability of *F. avicula.*

Flabellum cf. *siciliense* Milne Edwards & Haime, 1848
Fig. 23

cf. *Flabellum siciliense* Milne Edwards & Haime, 1848: 262.
cf. *Flabellum siciliense* – Seguenza, 1864: 482-483, tav. 10, fig. 5.
cf. *Flabellum siciliense* – Seguenza, 1880: 302.
cf. *Flabellum avicula* var. *siciliensis* – Simonelli, 1896: 169, figg. 6-8.
cf. *Flabellum siciliense* – Chevalier, 1961: 381.
cf. *Flabellum siciliense* – Spadini, 2015: 97-99, figg.124-127.

Occurrence and material – Parque Antena (one incomplete specimen)

Type material – Two syntypes from the Pliocene of Palermo are kept in the Milne Edwards collection of the MNHN in Paris (MNHN.F.M01304). Two topotypes are kept in the Seguenza collection in Florence (specimens IGF10484E).

Description – Corallum solitary, laterally compressed, 20.3 mm tall with calice diameters 21.9 x 17.0 mm and d/D = 0.59. Angle of basal thecal edge about 66° and inclination of lateral faces 61-73°.
Theca irregularly corrugated, lateral faces slightly convex. Calice non completely preserved. A total of 80 septa arranged hexamerally in five incomplete cycles. S_{1-3} large with straight vertical inner edges. S4 thinner than S1; S5 reduced compared to previous septa. Septal granules small and sparse.
Fossa moderately deep. Columella formed by lower edge of S_{1-3}.

Stratigraphic distribution – Miocene of Turin hills, Tortonian of Emilia, Redonian of northern Europe, Pliocene of Calabria, Sicily, Tuscany and Rhodes (Chevalier, 1961; Spadini, 2015). The specimen of *F. avicula* illustrated by Annoscia (1963, fig. 2) from the Pleistocene of Venosa is consistentwith *F. siciliense.*

Remarks – The specimen examined has five incomplete cycles, but the calice is not complete and the septa of the fifth cycle are not entirely conserved.

Flabellum sp.
Fig. 26

Occurrence and material – Chincheta (one very incomplete specimen).

Description – Corallum solitary, poorly preserved, 19.3 mm tall with calice diameter 21.8 x 8.9 mm. The peduncle is very evident, the lateral margins appear in the same line at an angle of about 180°. The lower face is flat, the other concave, but the margins are completely missing. The lower face is decorated with festoons that are missing on the upper face. Number of septa cannot be determined.

Observations – The species is similar to *Flabellum vaticani* Ponzi, 1876 and *Flabellum peolae* Osasco, 1895, but the preservation in the observed material does not allow a reliable diagnosis.

Suborder DENDROPHYLLIINA
Vaughan & Wells, 1943
Familia Dendrophylliidae Gray, 1847
Genus *Balanophyllia* Wood, 1844

Type species – *Balanophyllia calyculus* Wood, 1848, by monotypy.

Diagnosis – Solitary conical or cylindrical corallum, with monocyclic or polycyclic base, sometimes covered by an epitheca; septa arranged according to the Pourtalès plan.

Remarks – The genus *Balanophyllia* is subdivided into two subgenera: *Balanophyllia* (s.s.), comprising species with polycyclic base, and *Eupsammia* Milne Edwards & Haime, 1848 (type species *Madrepora trochiformis* Pallas, 1766, by subsequent designation (Milne Edwards & Haime, 1850) from the Lutezian (Middle Eocene) of France) which includes free species with monocyclic base.
According to Cairns (2001) this genus includes 174 species: 129 in the nominal subgenus and 45 in the subgenus *Eupsammia*. In the Mediterranean today, there are four species of *Balanophyllia* s.s. (Zibrowius, 1980).
In Pliocene deposits of the Mediterranean Sea, *Eupsammia*, albeit in sharp decline, is well represented by many fixed and a smaller number of free species (Spadini, 2015).
Balanophyllia praelonga Michelin, 1841 and *B. irregularis* Seguenza, 1864 have been reported from the Pliocene of Cataluña (De Angelis, 1894).

Balanophyllia (*Balanophyllia*) cf. *subcylindrica*
(Philippi, 1854)
Fig. 19

Occurrence and material – Chincheta (one specimen).
Description – Corallum solitary, cylindrical, with an enlarged base, 10.6 mm tall, calice diameter 8.5 x 10.3 mm. The costae are equal, covered with granules arranged in single file. Calice not preserved. About 72 septa are arranged hexamerally in five incomplete systems, according to a very regular Pourtalès plan. Columella elongate, probably spongiose.

Remarks – The specimen, not very developed in height, has features compatible with *B. subcilindrica*, although the columella is more developed as in *B. italica* (Michelin, 1841).

Balanophyllia (*Eupsammia*) cf. *praelonga*
(Michelotti, 1838)
Fig. 28

Occurrence and material –Parque Antena (two specimens).

Description – Corallum ceratoid, with incomplete epitheca. Calice diameter 12,3 x 10.2 mm and height of corallite 35,3 mm. The corallite bears 68 costae with small irregularly disposed granules. Intercostal space covered by thin epitheca. Calice regularly circular, incomplete. About 68 septa arranged in the Pourtalès plan. Columella elongated, not well preserved.

Remarks – The corallite is poorly preserved. This makes specific determination of the specimens very uncertain.

Genus *Dendrophyllia* Blainville, 1830

Species type – *Madrepora ramea* Linnaeus, 1758, by subsequent designation (Milne Edwards & Haime, 1850).

Diagnosis – Colonial, branched corallum. Septa inserted according to Pourtalès plan. Spongy or papillose columella. Epitheca absent, well-defined costae covered with granules. Endothecal dissepiments in some species.

Remarks – The genus *Dendrophyllia* includes over 80 species (Cairns, 2001) currently distributed in the Indo-Pacific and eastern Atlantic (Cairns *et al*., 1999) where there are three species. Two, *D. ramea* and *D. cornigera* Lamarck, 1822, also live in the Mediterranean Sea (Zibrowius, 1980).
About thirty species are known from the Neogene (De Angelis, 1895, Simonelli, 1895, 1896; Osasco, 1897; Montanaro, 1931; Zuffardi-Comerci, 1932; Chevalier, 1961; Cairns, 2001; Spadini, 2015) including *Dendrophyllia ramea* and *D. cornigera*. The Estepona basin features at least three species of *Dendrophyllia*, but the specimens are extremely incomplete and fragmented. This makes their classification very uncertain.

Dendrophyllia sp. 1
Fig. 29

Occurrence and material – Chincheta (one colony).

Description – Corallum colonial with irregular or encrusting base, branching at various heights with very short circular branches, always incomplete, 44.0 mm

tall and maximum diameter 32.8 mm. Ornamentation consisting of flat sinuous costae at base with fine denticles arranged in a disordered manner and partially or completely obliterated intercostal spaces. Near calices the costae become more prominent, always adorned with fine granulations.
Calices not preserved, branches from circular to slightly oval. The branch of smaller dimensions has 48 septa arranged regularly according to the Pourtalès plan, while the larger branch seems to have five complete cycles. Septa, perforated at peripheral margins, are decorated with very fine granules arranged in rows parallel to the distal edge.
Spongy columella, circular in smaller and elongated in larger calices.

Remarks – The colony described is similar to those shown in Spadini (2015: 126-130, figs 164-165) as *D.* cf. *cornigera*.

Dendrophyllia sp.2
Fig. 30

Occurrence and material – Chincheta and Parque Antena (fragments).

Description – Colonies small, arborescent or bushy and sparsely branched. Largest fragment examined only 27 mm tall and 7 mm in maximum diameter.
Costae convex, covered by very small granules arranged in a disorderly manner. Non porous intercostal striae narrow and shallow.
There seem to be two types of calice: smaller lateral ones with three cycles of septa (24-48 septa) and larger axial ones with four or five cycles of septa (48-96 septa), maximum diameter 5 mm. Fossa deep. Septa arranged in Pourtalès plan. All septa are slightly exserted and reach the columella deep in the fossa.
Septa with sharp granules. Columella reduced or hemispherical, composed of small flat papillae or trabeculae tightly fused together.

Remarks – This species shows affinity with certain Miocene species, including *D. alternicosta* Chevalier, 1961 and *D. collongeoni* Falsan & Locard, 1866 (cf. Chevalier, 1961).

Dendrophyllia sp.

Occurrence and material – Parque Antena and Chincheta (some fragments in bad condition).

Remarks – The scarcity of the studied material and its poor preservation state made it impossible to determine the species with certainty. The only possible statement is that at least three species of *Dendrophyllia* are probably represented in the corallofauna of the Pliocene Basin of Estepona. *D. cornigera* has already been reported from Catalonia by De Angelis (1894).

Genus *Enallopsammia* Michelotti, 1871

Type species – *Coenopsammia scillae* Seguenza, 1864 by subsequent designation (Michelotti in Sismonda, 1871).

Diagnosis – Corallum colonial produced by extratenticular budding. Corallites sympodially or unifacially arranged, resulting in bushy or planar coralla. Septa in three cycles, normally arranged. Columella small.

Remarks – *Enallopsammia* includes dendroid forms characterized by small calices with 24 septa and is distinguished from *Dendrophyllia* by septa not ordered according to Pourtalès plan and by the lack of endotheca (Cairns, 2001).
Some fossil species (Chevalier, 1961) and various extant species living in the Pacific and Atlantic (Cairns *et al*., 1999) are included in the genus *Enallopsammia*.

Enallopsammia sp.
Fig. 31

Occurrence and material – Chincheta (one fragment).

Description – Fragment of a large branch, 29 mm long and with a diameter of 11.2 x 9.3 mm. On the surface there are 8 calices all facing the same side. The calices are not completely preserved and have a maximum diameter of about 3 mm. Septa normally arranged with three cycles of septa. Columella papillose and small. Two calices show not well developed costoseptal rostra.

Remarks – This fragment is probably related, from a morphological point of view, to *E. rostrata* (Pourtalès, 1878), currently living in the Atlantic Ocean, which is very similar to *E. scillae* (Seguenza, 1864) from the Mio-Pliocene of Italy.

Concluding remarks

The scleractinian fauna of the Pliocene of Estepona Basin belongs to at least 27 species. At the study sites the more diverse family is Caryophylliidae with 13 species, followed by Flabellidae with 6 species, Dendrophylliidae with 5 species, Oculinidae with 2 species and Micrabacidae and Turbinoliidae with one species each.
Of the studied species, 17 were found in Parque Antena, 21 in Chincheta and 5 in Valerín-Carretera; among them 4 are common to all three localities, 5 are found exclusively in Parque Antena and 8 exclusively in Chincheta (Tab. 2).
These corallofauna species are exclusively azooxanthellate, ahermatypic and non-constructional. In most cases they are solitary species belonging to the genera *Stephanophyllia*, *Caryophyllia*, *Ceratotrochus*, *Conotro-*

chus, *Paracyathus*, *Trochocyathus*, *Sphenotrochus*, *Flabellum* and *Balanophyllia*, but there are also several colonial species belonging to the genera *Cladocora*, *Bathelia*, *Madrepora*, *Coenocyathus*, *Pourtalosmilia*, *Dendrophyllia*and *Enallopsammia*.

Most of the listed species are associated with soft bottoms, principally in infralittoral or circalittoral environments. Only some belong to genera that prefer circalittoral or bathyal deep sea bottoms, such as *Bathelia*, *Madrepora*, *Ceratotrochus* (*Ceratotrochus*) and *Aulocyathus*.

Both qualitatively and quantitatively, only afew species are related to hard or detrital bottoms: *Caryophyllia felsinea*, *Caryophyllia granulata*, *Paracyathus* sp., *Balanophyllia* cf. s*ubcylindrica*, *Dendrophyllia* spp. and *Enallopsammia.*

Distinctive elements of the scleractinian fauna of Estepona are the following:

- a large species of *Stephanophyllia* corresponding to *S. stefanini*, here dubitatively assigned to *S. elegans*;
- a species of *Bathelia* already reported from the Pliocene of Siena and a species of *Madrepora*, doubtfully assigned to *M. oculata*;
- a species of *Ceratotrochus* (*Edwardsotrochus*) with pentameral symmetry, never hitherto reported from the Mediterranean Pliocene;
- a first report of the genera *Paracyathus*, *Trochocyathus*, *Aulocyathus* from the Spanish Pliocene;
- a first report of *Sphenotrochus intermedius* from the Pliocene of the Mediterranean Sea;
- a species of small *Dendrophyllia*, not hitherto known from the Pliocene of the Mediterranean Sea;
- a species of *Enallopsammia* related to *E. scillae* and/or *E. rostrata*.

The scleractinian fauna of Estepona and that described by De Angelis (1894) and Castells (1978) from Cataloña have only a few species in common. This may be due to different geographical positions and a direct influence of the Atlantic domain on the Estepona Basin (Aguirre *et al*., 2006), as well as to our incomplete knowledge of this fauna.

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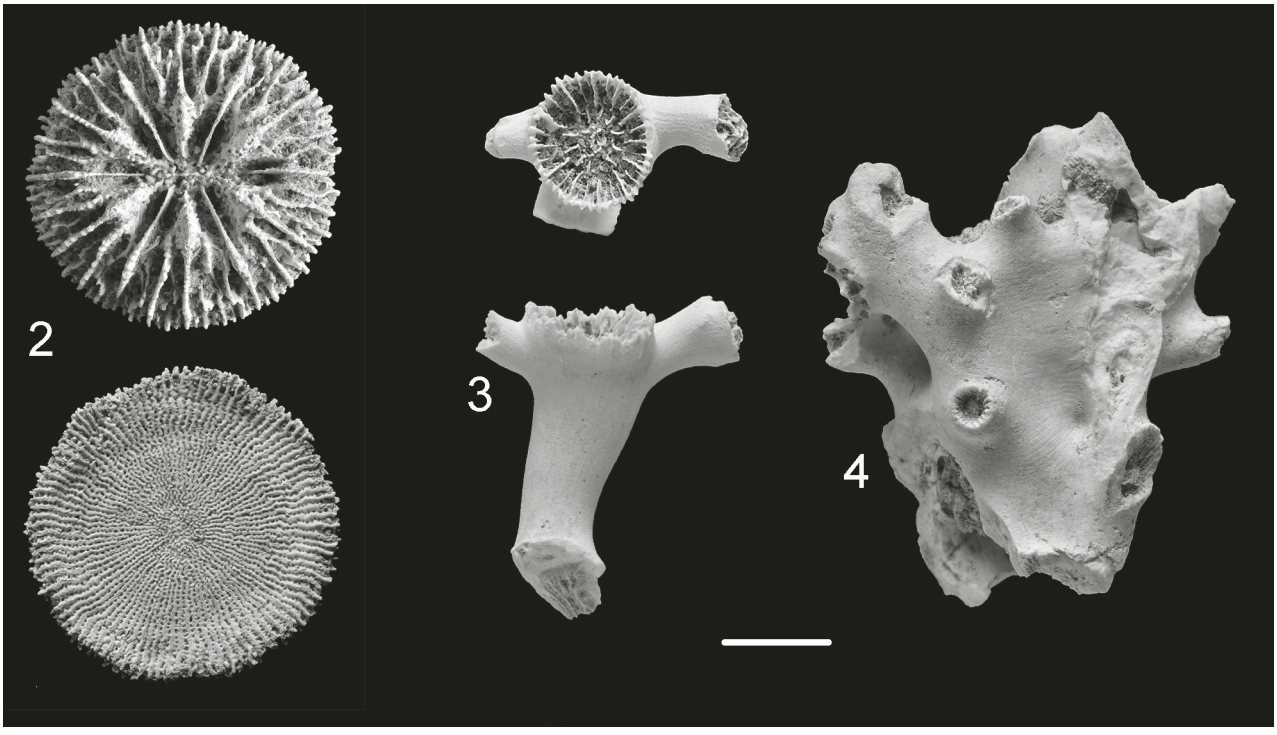


Figures 2-4. Micrabaciidae and Oculinidae from Pliocene of Estepona.

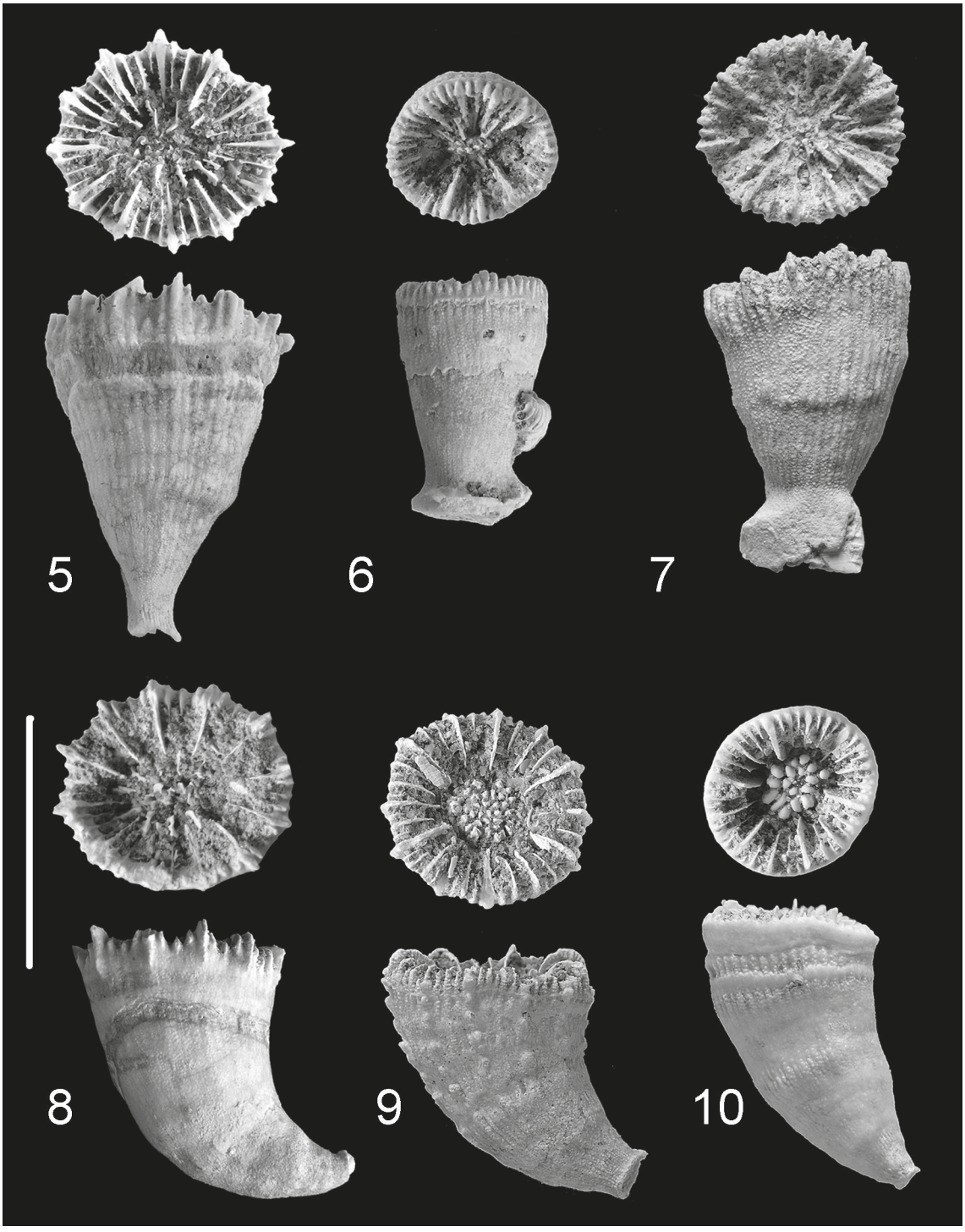
Figure 2. *Stephanophyllia* cf. *elegans* Bronn, 1837; Pliocene of Parque Antena.
Figure 3. *Bathelia* sp.; Pliocene of Chincheta.
Figure 4. *Madrepora* cf. *oculata* Linnaeus, 1758; Pliocene of Chincheta. (Scale bar = 10 mm)

Table 1. Species already known or cited from the Spanish Pliocene.

Species	Barrois & Offret, 1889	De Angelis, 1894	Castells, 1989	note
Astrocoenia almerai De Angelis, 1894		•		= *Madracis almerai*
Cladocora coespitosa (Linnaeus, 1767)		•		
Cladocora granulosa Goldfuss, 1838		•		= *C. caespitosa*
Caryophyllia clavus Scacchi, 1835		•		= *C. smithii*
Coenocyathus corsicus Milne Edwards & Haime, 1848		•		
Coenocyathus anthophyllites Milne Edwards & Haime, 1848		•		
Coenocyathus cylindricus Milne Edwards & Haime, 1848		•		
Coenocyathus affinis? Michelotti (in De Angelis, 1894)		•		
Flabellum avicula Michelotti, 1838		•	•	
Flabellum intermedium Michelotti, 1841		•	•	
Flabellum extensum Milne Edwards & Haime, 1848			•	
Flabellum distinctum Milne Edwards & Haime, 1848		•		= *F. extensum*
Flabellum malagense Barrois & Offret, 1889	•			
Flabellum michelini? Milne Edwards & Haime, 1848		•		
Balanophyllia praelonga Michelotti, 1838		•		
Balanophyllia irregularis Seguenza, 1864		•		
Dendrophyllia amica Michelotti, 1838		•		
Dendrophyllia cornigera de Blainville, 1868		•		

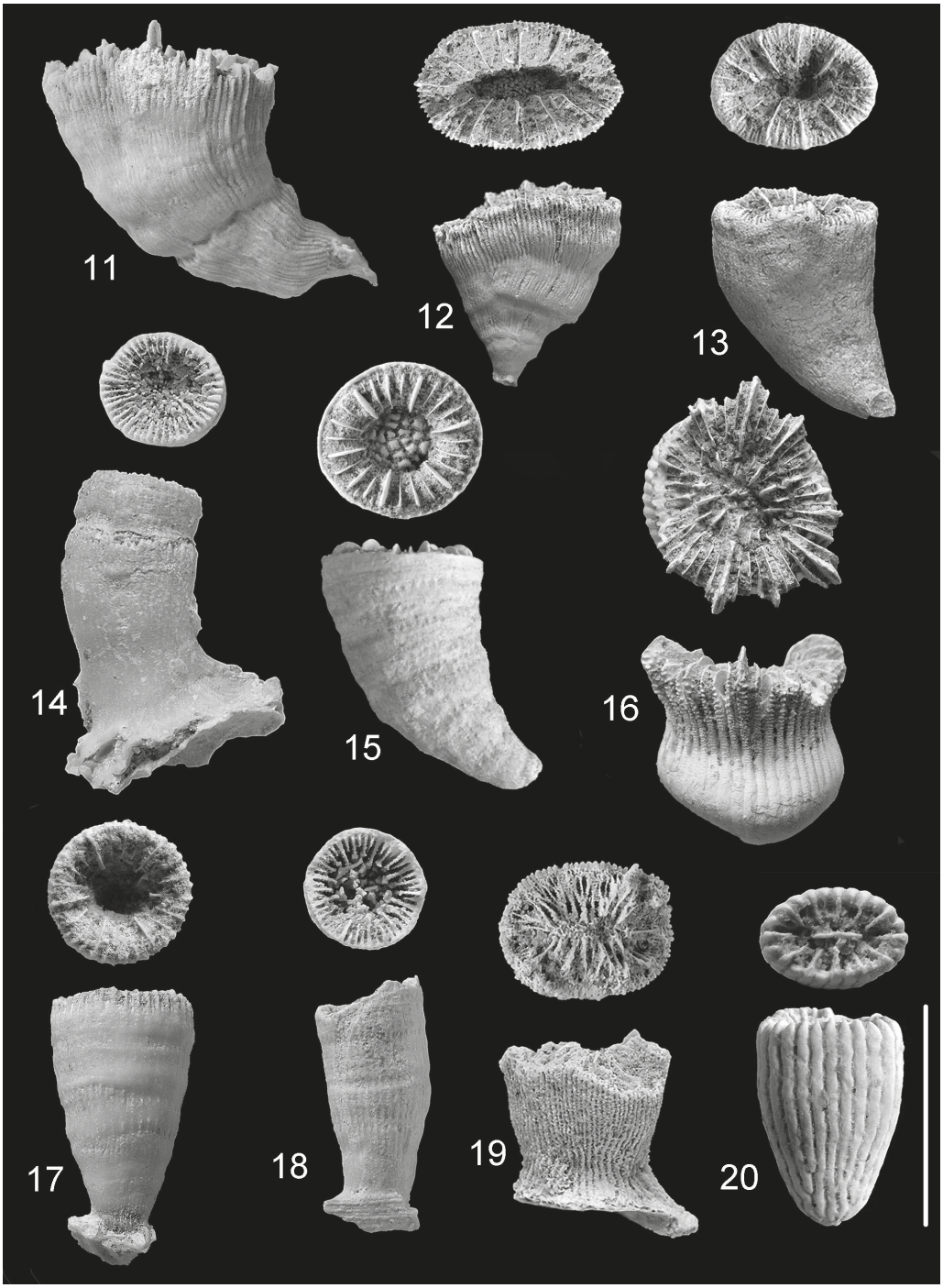
Table 2. Pliocene scleractinians from Parque Antena, Valerin Carretera and Chincheta (Estepona, Spain).

	Parque Antena	Chincheta	V-Carretera
Stephanophyllia cf. *elegans* Bronn, 1831	X	X	
Bathelia sp.	X	X	
Madrepora cf. *oculata*		X	
Caryophyllia (*Caryophyllia*) *felsinea* Simonelli, 1895	X	X	
Caryophyllia (*Caryophyllia*) *granulos*a De Angelis, 1894		X	
Caryophyllia (*Caryophyllia*) sp.		X	
Caryophyllia (*Ceratocyathus*) *simplex* Seguenza, 1864	X	X	
Ceratotrochus (*Ceratotrochus*) *multispinosus* Michelotti, 1838	X		
Ceratotrochus (*Ceratotrochus*) sp.	X	X	X
Ceratotrochus (*Edwardsotrochus*) *duodecimcostatus* Goldfuss, 1826	X	X	
Ceratotrochus (*Edwardsotrochus*) sp.		X	
Coenocyathus cylindricus sensu De Angelis, 1894		X	
Aulocyathus cf. *atlanticus* Zibrowius, 1980	X	X	
Paracyathus sp.	X		
Trochocyathus sp.	X	X	X
Pourtalosmila sp.	X		
Sphenotrochus intermedius Munster in Goldfuss, 1829		X	
Flabellum cf. *asperum* Milne Edwards & Haime, 1848	X	X	X
Flabellum cf. *malagense* Barrois & Offret, 1886		X	X
Flabellum cf. *siciliense* Milne Edwards & Haime, 1848	X		
Flabellum sp.		X	
Balanophyllia (*Balanophyllia*) cf. *subcylindrica* Philippi, 1854		X	
Balanophyllia (*Eupsammia*) cf. *praelonga* Michelotti, 1838	X		
Dendrophyllia sp.1	X	X	
Dendrophyllia sp.2	X	X	
Dendrophyllia sp.	X	X	X
Enallopsammia sp.		X	



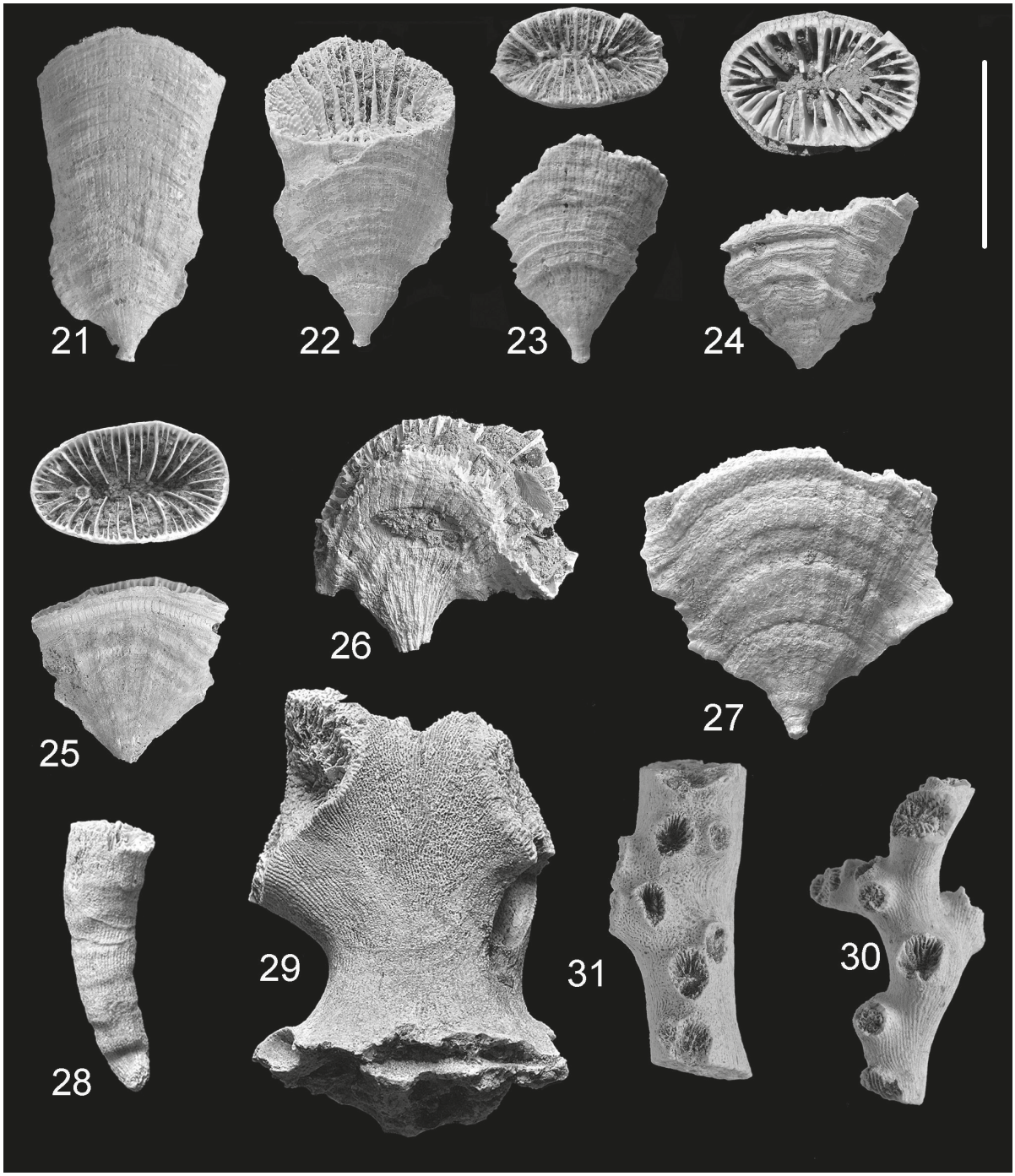
Figures 5-10. Caryophylliidae from Pliocene of Estepona.

Figure 5. *Caryophyllia* (*Caryophyllia*) *granulosa* De Angelis, 1895; Pliocene of Chincheta.
Figure 6. *Caryophyllia* sp. Pliocene of Chincheta.
Figure 7. *Caryophyllia* (*Caryophyllia*) *felsinea* Simonelli, 1895; Pliocene of Parque Antena.
Figure 8. *Caryophyllia* (*Ceratocyathus*) *simplex* Seguenza, 1864; Pliocene of Parque Antena.
Figure 9. *Ceratotrochus* (*Ceratotrochus*) *multispinosus* Michelotti, 1838; Pliocene of Parque Antena.
Figure 10. *Ceratotrochus* (*Ceratotrochus*) sp. Pliocene of Parque Antena. (Scale bar = 10 mm).



Figures 11-20. Caryophylliidae, Turbinoliidae and Dendrophylliidae from Pliocene of Estepona.

Figures 11-12. *Ceratotrochus (Edwardsotrochus) duodecimcostatus* Goldfuss, 1826; Pliocene of Parque Antena.
Figure 13. *Ceratotrochus (Edwardsotrochus)* sp. Pliocene of Chincheta.
Figure 14. *Paracyathus* sp.; Pliocene of Parque Antena.
Figure 15. *Ceratotrochus*(*Ceratotrochus*) sp. Pliocene of Parque Antena.
Figure 16. *Trochocyathus* sp.; Pliocene of Parque Antena.
Figures 17-18. *Aulocyathus* sp. Pliocene of Parque Antena.
Figure 19. *Balanophyllia* (*Balanophyllia*) cf. *subcylindrica*. Pliocene of Chincheta.
Figure 20. *Sphenotrochus intermedius* Munster in Goldfuss, 1829; Pliocene of Chincheta. (Scale bar = 15 mm excl. fig. 20 = 5 mm).



Figures 21-31. Flabellidae and Dendrophylliidae from Pliocene of Estepona.

Figures 21-22. *Flabellum* cf. *asperum* Milne Edwards & Haime, 1848; Pliocene of Parque Antena.
Figure 23. *Flabellum siciliense* Milne Edwards & Haime, 1848; Pliocene of Parque Antena.
Figure 24-25. *Flabellum malagense* Barrois & Offret, 1886; Pliocene of Parque Antena.
Figure 26. *Flabellum* sp. Pliocene of Chincheta.
Figure 27 *Flabellum intermedium* (Michelin, 1841); Pliocene of Chincheta.
Figure 28. *Balanophyllia (Eupsammia)* cf. *praelonga* Michelotti, 1838; Pliocene of Parque Antena.
Figure 29. *Dendrophyllia* sp.1; Pliocene of Parque Antena.
Figure 30. *Dendrophyllia* sp. Pliocene of Parque Antena.
Figure 31. *Enallopsammia* sp. Pliocene of Chincheta. (Scale bar = 20 mm).

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