RENDICONTI Società Italiana di Mineralogia e Petrologia, 37 (2), 1981: pp. 703-718

VANDA ROLANDI *

GEMS FROM THE ANIMAL KINGDOM: A GEMMOLOGICAL STUDY OF MATERIALS FROM CNIDARIA

ABSTRACT. — Amongst gems from the Animal Kingdom, several materials derived from parts (skeleton) of animals belonging to phylum Cnidaria have been very much appreciated throughout time. Generally named « Corals », they are taken from species of the same phylum, but belong to different orders; structure and composition (calcareous, horny or proteinous) often differing greatly. This is the reason why the Author collected and examined all these various materials in order to facilitate identification without having to resort to destructive analysis methods. Firstly, the specimens were completely classified (phylum, class, subclass, order, suborder, family, genus and species) according to F. M. BAYER'S classification (1956).

A gemmological study was then carried out for each species (or genus), the characteristics taken into consideration being: appearance of cut and polished material, microscopic characteristics, specific gravity, refraction indices, effects under ultra violet- and X-rays.

These results are used in recognising the composition and zoological classification of cut pieces derived from Cnidaria and used as gems.

Key words: Coelenterata (44), skeleton (41-58), actuogeology (02-39), quarrying stone (37-37), classification (02-75), physical characteristics (04), electromagnetical characteristics (05).

RIASSUNTO. — Numerosi materiali provenienti dal Regno Animale hanno la possibilità di essere utilizzati come gemme. In modo particolare le parti (scheletri) di animali appartenenti al phylum Cnidaria, tagliate e lucidate, sono state molto apprezzate in ogni tempo e sono note con il comune appellativo di « coralli ».

Tra i coralli in senso lato si annoverano tuttavia materiali con caratteristiche molto diverse, sia per quanto riguarda la composizione (calcarea, cornea o proteinica) sia per la struttura. Per contro, coralli di aspetto molto simile e di composizione analoga possono derivare addirittura da generi appartenenti a sottoclassi diverse. Questo appare evidente qualora si esamini l'animale completo di parti molli, ma di fronte ad un pezzo di scheletro tagliato e lucidato mancano a tutt'oggi le basi per un sicuro riferimento alla posizione zoologica dell'esemplare e quindi anche alla sua classificazione genetica gemmologica. Va inoltre sottolineato che in campo gemmologico è di fondamentale importanza poter completare l'analisi con metodi non distruttivi, prendendo in considerazione caratteristiche microscopiche e dati fisici. A questo scopo l'Autrice ha raccolto ed esaminato tutti gli scheletri di Cnidari che possono fornire materiali ornamentali. Questi sono stati dapprima classificati (phylum, classe, sottoclasse, ordine, famiglia, genere e specie) secondo F. M. BAYER (1956); successivamente sono stati definiti dal punto di vista gemmologico mediante il rilievo dei seguenti dati: aspetto del materiale tagliato e lucidato, caratteristiche microscopiche, peso specifico, indici di rifrazione, effetti di luminescenza ai raggi ultravioletti e ai raggi X.

La finalità del presente lavoro è quindi di fornire gli estremi per un'esatta classificazione genetica dei coralli-gemme (ossia tagliati e lucidati), senza dover ricorrere alla distruzione parziale o totale degli esemplari.

Dal punto di vista gemmologico il vantaggio di una tale inquadratura è la possibilità di risalire alla composizione e alla struttura di questi materiali, per definire provenienza e grado di durabilità di ciascuno e mettere quindi in evidenza eventuali trattamenti.

* Servizio Pubblico di Controllo per le Pietre Preziose e le Perle della Camera di Commercio di Milano, via dei Mercanti 2, 20121 Milano (Italia).

Many different materials from the Animal Kingdom are held to be suitable for cutting and polishing on account of their hardness and tenacity, and are therefore used as gems.

Some of these are derived from *animal secretions* and others from *parts of animals,* according to the gemmological classification based on genetical criteria by M. Superchi (1978).

Among the gems from parts of animals, skeletons of some marine invertebrates belonging to phylum Cnidaria (group Radiata) have been the most highly appreciated from time immemorial on account of their greater hardness and higher lustre (due to their compact texture) and, at the same time, of their subtranslucence and wide range of colours.

Cnidaria (previously grouped together with Ctenofora, under Coelenterata) are *solitary or colonial* animals of a low order of organization, having a fundamentally biradial structure; the body wall is a single cavity, the coelenteron, from which it originally took its name. The firm skeletons of some genera, cut and polished and generally called « corals », were already known in the Mesopotamian civilisation (there are no earlier archaeological reports than this) and their value has been preserved throughout the centuries. Although it has stirred up wide and continuous interest, this kind of material was practically unknown from a genetical point of view until the beginning of the 18th century, when, in 1723, its origin from the Animal Kingdom was demonstrated by G. A. Peyssonel. Since then, uninterrupted research has led to further zoological knowledge and wide classification which is much more complete.

Today, many new materials belonging to phylum Cnidaria find use as gems, but they cannot be confusedly called « corals ». It is important to establish the exact denomination of each one of them as the variations from a zoological standpoint are to be found in a different structure and chemical composition (calcareous, horny or proteinous). Taxonomical classification of an animal is determined by using the complete organism and it is often very difficult to classify the nonperishable parts only. The latter, cut and polished, sometimes even treated to enhance their colour, are the only parts available in the gemmological field.

Variations in chemical composition, size and arrangement of the components could demonstrate their belonging to different orders, genera and species, but to evidence these aspects, a destructive analysis is required.

The gemmologist must determine the taxonomy of these specimens without destroying them. He is interested therefore in the zoological denomination and descriptions of the cut materials, equipped with all the statistics which are usually the result of analysis of applied gemmology (certification).

For this reason the skeletons of genera and species usable as gems have been analized using non-destructive methods, recognizing microscopical structures and physical data on cut and polished pieces. Main taxonomical characteristics according to F. M. Bayer's classification (1956) (table 1) and aspect of the surfaces are reported

TABLE 1

Cnidaria with skeleton usable as a gem, according to F. M. BAYER'S *zoological classification (1956)*

KINGDOM	GROUP	PHYLUM	CLASS	SUBCLASS	ORDER	SUBORDER	FAMILY	GENUS	SPECIES
Animal	Radiata	Cnidaria	Hydrozoa		(Milleporina)		(Milleporidae)	(Millepora)	
					Stylasterina		Stylasteridae	Stylaster Allopora	nobilis
					Stolonifera		Tubiporidae	Tubipora	musica
					Coenothecalia		Helioporidae	Heliopora	coerulea
			Anthozoa	Octocorallia or Alcyonaria			Coralliidae	Corallium	elatius japonicum rubrum secundum
						Scleraxonia	Melithaeidae	Melithaea	ochracea
					Gorgonacea		Primnoidae	Plumarella	
							Gorgoniidae	Gorgonia	
						Holaxonia	Plexauridae	Eunicella	
							Chrysogorgiidae	Chrysogorgia	
							Isididae	Keratoisis	
						Astrocoeniina	Pocilloporidae	Pocillopora Seriatopora	
							Acroporidae	Acropora	
					Madreporaria	Fungiina	Fungiidae	Fungia Herpolitha	
							Poritidae	Porites	
				Hexacorallia or Zoantharia		Faviina	Oculinidae	Madrepora Cyathelia	oculata
							Faviidae	Diploastraea	heliopora
					Zoanthinaria		Gerardiidae	Gerardia	savaglia
					Antipatharia		Antipathidae	Parantipathes	larix

in the following descriptions; physical statistics have been grouped in a conclusive table.

Class HYDROZOA

The skeleton is an exoskeleton and, if present, is either chitinous (and perishable) or, rarely, calcareous. Polyps are simpler than in other Cnidaria and show a variable number of tentacles.

Order Milleporina

Genus *Millepora*: it is the only genus of this order. Its entire stony mass is perforated by large pores surrounded by smaller ones and is transversed by a complex system of branched canals. It therefore has a porous texture because of which it was named « White Sugar Coral » and for this same reason it is unsuitable for cutting.

Order Stylasterina

Genus *Stylaster*: the material has a pinkish-orange colour, shows a certain subtranslucency and can be highly polished. Some pores, arranged in circles (cyclo-systems), can be noted on the surface. They are to be found on a small prominence above the surface and exhibit a number of radially arranged ridges resembling the septa of Madreporaria. When still more prominent, they are also called « calices », but bear no homology with the calices of Madreporaria. In

each of these calices there is a gastropore at the hub and ten or more dactylopores in the circle close to the margin. In each of the pores there is a short tubercolated style, the presence of which is the origin of the generic name.

Genus *Allopora,* species *nobilis*: the material is orange, red or purplish-violet in colour, with a white irregular central core. As in the genus *Stylaster,* some surface pores are arranged in cyclo-systems (fig. 1), showing a gastropore in the central position and a variable number of dactylopores around it. These cyclo-systems are also called « calices », but they are not so prominent as in the genus *Stylaster*.

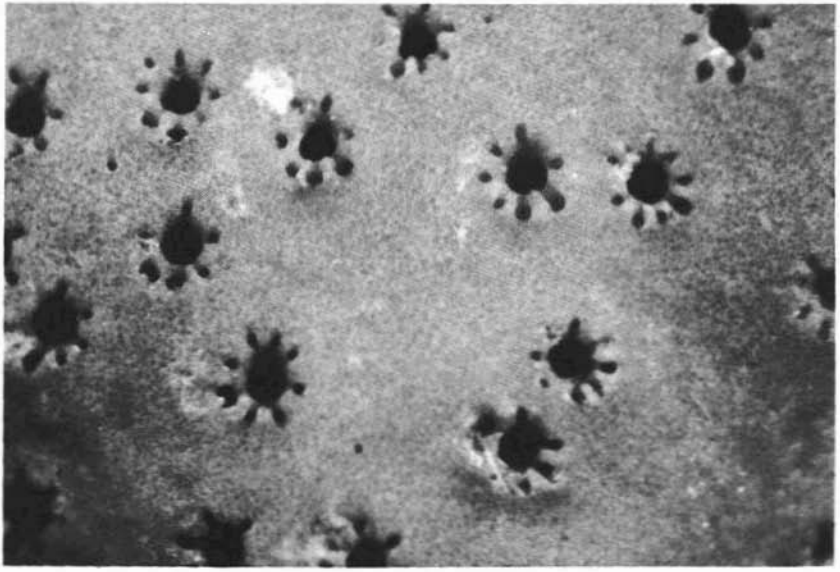

Fig. 1. — *Allopora nobilis*: surface pores arranged in cyclo-systems, 18 x.

Class ANTHOZOA

The majority of these Cnidaria possess a skeleton formed by either calcium carbonate or a horn-like or proteinous substance.

Subclass OCTORALLIA or ALCYONARIA

The Alcyonaria are colonial in habit. Polyps show eight tentacles and a general octoradiate symmetry in their organisms. An important characteristic of all the Octocorallia (exception made by the genus *Heliopora*) is the ability to form calcareous (generally aragonitic) spicules, separated at the beginning and subsequently fused with one another to form the skeleton. The form of the spicules is different in the different species and this represents an important diagnostic feature. The spicules contain a pigment to which is due the colour of these corals.

As above mentioned, the only one exception of this subclass is the genus

Heliopora, whose stony calcareous skeleton is formed by crystalline fibres of aragonite, fused from the beginning into lamellae: so this skeleton has a close texture from its formation.

Order Stolonifera

Genus *Tubipora,* species *musica*: known as « Organ-pipe Coral », it is made up of a number of cylindrical tubes, parallel to one another and bound together by a series of transverse plates. The firm coral substance or « corallum » exhibits a number of small spaces or pores, caused by the non-complete fusion of the spicules. It is therefore brittle. It was used in very early times in Egypt for making into small beads for ornaments and was called « Batu Swangi » or Magician's Stone by the Malays.

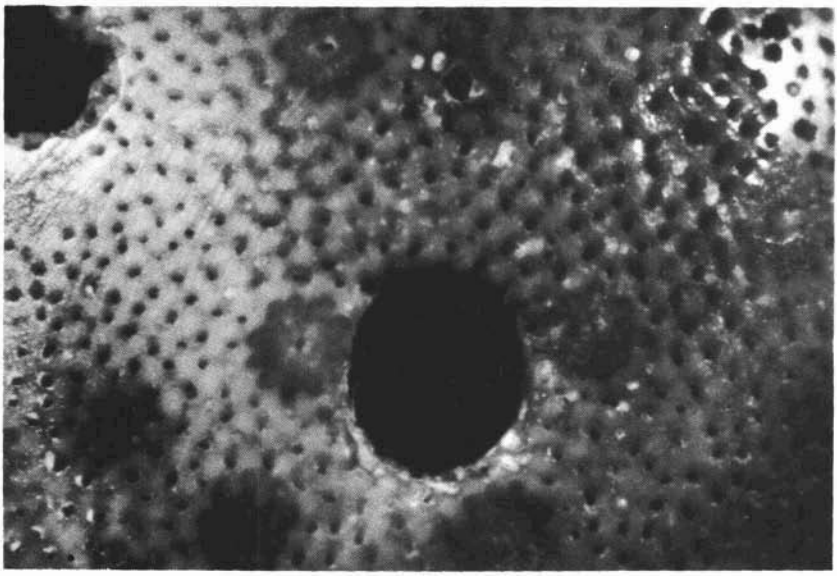

Fig. 2. — *Heliopora coerulea*: large and small surface pores, 18 x.

Order Coenothecalia

Genus *Heliopora,* species *coerulea*: known as « Blue Coral », this is the only coral possessing a blue colour, thus giving it its specific name. The surface is smooth, but cannot be highly polished. It is perforated by two kinds of pores, both large and small, the latter being much more numerous (fig. 2). On examining the large pores a variable number of shallow ridges (pseudosepta) can be seen; in transverse section the pores pass into a series of parallel tubes.

Order Gorgonacea, suborder Scleraxonia

Genus *Corallium,* species *elatius*: the surface becomes after cutting smooth and highly polished and shows a certain subtranslucency. Parallel to the core a

series of thin longitudinal strips, different in size, are arranged alternately in light pink-dark pink layers placed around a central white area, close to which they seem more sinuous. In transverse section numerous alternated pink and white strips, which are thinner toward the outer margin, form a concentric structure. In both sections a delicate secondary colourless structure appears on the flat surface. The pale rose homogeneous variety with a slightly bluish tinge (8:1:1 of DIN 6164 Colour System) is known as « Angel-skin » and comes from Tche Li Gulf (China and Vietnam).

Genus *Corallium*, species *japonicum*: this is known as « Japanese White Core Coral ». The surface, slightly subtranslucent, can be well polished. Colour is irregularly distributed and can vary from an intense orangey-red to orangey-pink with whitish spots. The core is interupted and irregular in length and width gradually changing to an intense orangey-red in the outer zone and is the characateristic of this coral. The structure varies from radial in the central area to concentric circular in the outer margin, where there are some whitish sub-translucent rings on an orangey-red background. Parallel to the core, some whitish longitudinal canals are found at a distance of roughly 1 mm.

Genus *Corallium*, species *rubrum*: shades of colour vary from dark red to red, orange-red, bright rose, pale rose and even white although the latter is considered the consequence of a diseased condition of the organism. This species possesses the hardest and densest skeleton of all Cnidaria and is the reason behind the specific lustre when polished. This is due to a particular structure of the axis which is formed and grows when the spicules (about mm 0.07 in length), after growing, become jammed together, so as to leave no space between them. The amalgamation is so complete that the individual outlines and spaces between them are entirely lost. In all varieties the surface can be well polished and shows a certain subtranslucency. A series of red or orange, sometimes sinuous canals, with whitish spots are arranged in the axial direction. Occasionally, especially in specimens from Tuscany (Italy), they appear crossed by numerous transverse and smaller canals, which terminate in secondary delicate twigs (about mm 0.1 in diameter) and often reach the surface (in specimens from Sardinia, Italy). In transverse section, on the outer side, some wavy circular lines, alternately coloured and whitish, can be seen. The specimens which have lain at the bottom of the sea in particular of Sardinia and Sciacca (Sicily, Italy) for a considerable length of time are called « burnt » and show a more yellowish tinge.

In these, in a section perpendicular to the axis, two concentric areas can be noted, in the outer of which deep canals are radially arranged.

One variety of this species having a pale rose homogeneous colour is called « Angel-skin », in a similar way to the pale rose homogeneous variety of *Corallium elatius* (see).

Genus *Corallium,* species *secundum*: the material is non-homogeneous in colour, presenting flesh-pink and pinkish-white areas alternately. The surface can be well polished. A series of subparallel strips is arranged in a sinuous structure which sometimes becomes parabolic in the axial direction. Small intense orange spots, arranged in blobs, are sparsely diffused on the surface.

Genus *Melithaea,* species *ochracea*: it is known as « Red King Coral ». The surface appears partly smooth and partly porous, composed of alternating hard red internodes of inseparably fused calcareous spicules and soft nodes of spongy, spiculiferous horny material with a yellowish tinge. Both nodes and internodes are perforated by canals which are sometimes placed round a central dark red area with numerous yellowish spots passing down into the centre of the axis.

Order Gorgonacea, suborder Holaxonia

The genera belonging to this suborder are made up of an axis consisting of either a horny substance alone (gorgonin), lower in sulphur content than keratin, or of horny material more or less permeated with calcareous substance.

Genus *Plumarella*: the axis is thin, made up of horny substance sometimes permeated with calcareous matter. In transverse section some concentric wavy lamellae of horny material, yellow in colour, are arranged round a dark brown, horny and compact central core. On the surface, the lamellae are arranged in parallel layers, alternately reddish-yellow and brown in colour.

Genus *Gorgonia*: as all the Gorgonacea belonging to the family Gorgoniidae, the central axis is made up of purely horny material; it has a narrow, but distinct chambered central core, less dense and hard, so that the material is sometimes hollow. The surface exhibits a certain subtranslucency. In the axial direction, on a yellowish background, numerous dark short lines (about mm 0.2) are arranged in longitudinal rows (fig. 3). The background structure is partly clepsydral and partly fibrillar. The axis is usually used to make into bracelets and rings.

Genus *Eunicella*: this belongs to the family Plexauriidae and the horny axis sometimes contains calcareous granules; the swollen base is frequently impregnated with carbonaceous salts. The surface exhibits a certain subtranslucency and a greasy lustre. The material is very dense, the central core being hard and compact with no central cavity. On the outer margin a series of wavy layers, lighter and with a brownish-yellow tinge, appears arranged in a concentric structure around the central black core.

It is used to make into bracelets and rings, but less frequently than *Gorgonia.*

Genus *Chrysogorgia*: the axis is highly calcified, continuous, glossy, iridiscent and metallic, made up of smooth concentric lamellae, sometimes undulating. It is also named « Golden Coral ».

Confined to deep water, very rare, it is quite impossible to be found on the market.

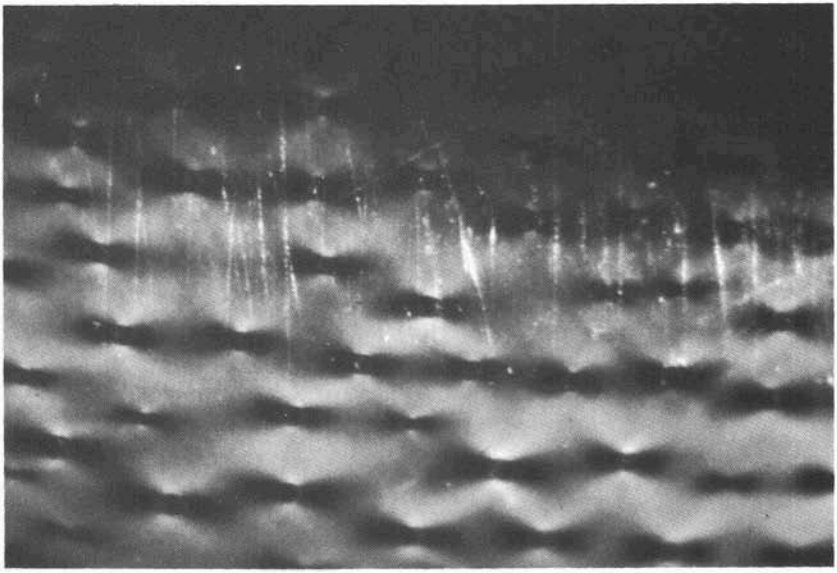

Fig. 3. — *Gorgonia*: surface structure in the axial direction showing rows formed by short lines and the clepsydral structure of the background, 29 x.

Fig. 4. — *Keratoisis*: two calcareous internodes and a horny node in a section perpendicular to the axis, 14.5 x.

Genus *Keratoisis*: the axis is composed of alternating purely horny nodes and yellowish non-spicular calcareous internodes showing a radial structure with a white core when polished (fig. 4). The internodes are fluted with grooves in

which nutritive canals are to be found. The horny nodes become brittle when dry. For both reasons the material does not seem very resistant. It is called « Bamboo Coral ». No cut and polished pieces have been found on the market.

Subclass HEXACORALLIA or ZOANTHARIA

This subclass includes solitary and colonial Anthozoans, with or without a calcareous exoskeleton, characterized by paired mesenteries and by insertion of new pairs of them after the first six, in two, four, or all six primary exocoels. The skeleton of the colonies has a more or less cup-like structure.

Order Madreporaria or « stony corals »

This includes colonial, rarely solitary animals, provided with a calcareous compact skeleton, formed by crystals of aragonite in a colloidal matrix and radiating from a central, probably organic material. When formed by a solitary polyp, it is called « corallite ». In the majority of species a large number of corallites combine to form the skeleton of an entire colony (corallum). There are poreless varieties and perforate forms. Corallum is formed by calices of corallites immersed in a compact stony mass (coenosteum). Colour derives from a pigment diffused in the soft tissues, soluble in alcohol and fading away after death.

Genus *Pocillopora*: the surface has a slight subtranslucency. The calices (about mm 1 in diameter) are very numerous and close together, dentate, with rudimentary septa. In addition to the two directive septa there are four other large septa alternating with six smaller ones. Some areas present a brownish colour, caused by infiltration of oxides.

Genus *Seriatopora*: the surface can be well polished, but is opaque. The calices, very small, are arranged in longitudinal series along the branches. In transverse section a radial structure is caused by a number of tubes divided into chambers, the outer of which reaches the surface to form the calyx. The corallum appears solid as there is no communication between one set of chambers and another.

Genus *Acropora*: this material, being difficult to polish, does not find use as a gem. The branches have an axial corallite larger than the more numerous radial corallites placed round it, as can be seen in the transverse section (fig. 5).

Genus *Fungia*: three different areas can be seen on the surface (fig. 6): the upper area, brownish in colour and opaque, the central area, very porous, greyish-white in colour and the under area, white and subtranslucent, which is the solid coral substance, representing the theca of the cup coral.

The limit between the upper and central area is lobed and exhibits a small brown discontinuous layer.

Genus *Herpolitha*: it has a typical elongated form. In the middle of the upper surface the septa appear to radiate from a number of distinct centres arranged in a fossular groove. The surface can be polished. It is slightly subtranslucent and exhibits a series of parallel strips with the same arrangement of the septa.

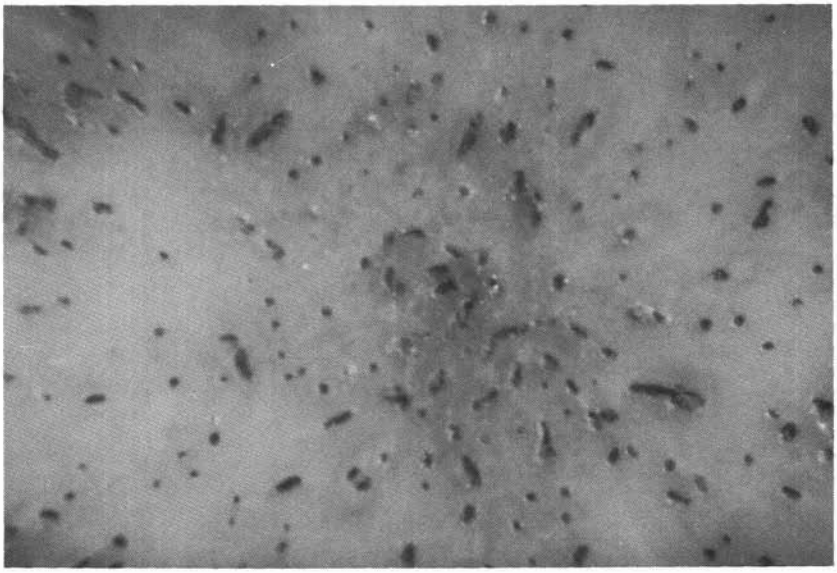

Fig. 5. — *Acropora*: surface structure showing numerous radial corallites around the centre, 12 x.

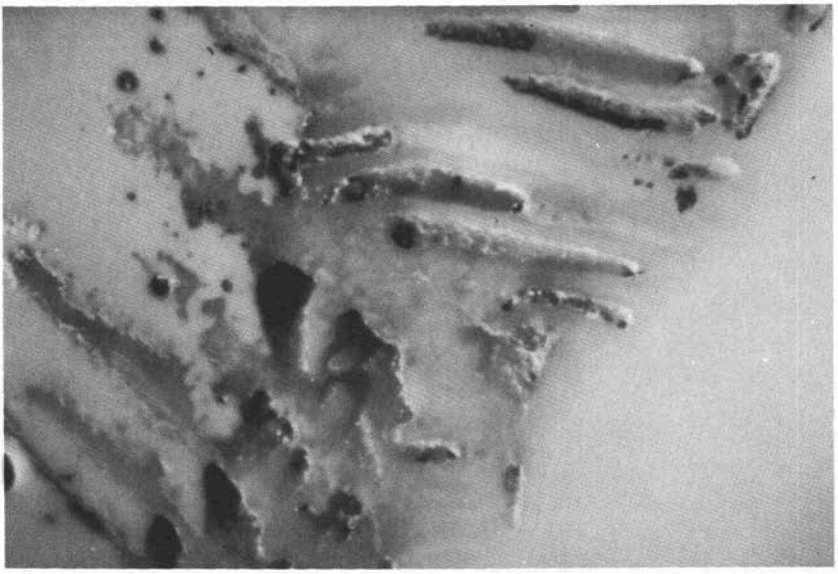

Fig. 6. — *Fungia*: transverse section showing three different areas, the upper opaque area, the middle porous area and the under subtranslucent area, which is the solid coral substance, 7.2 x.

Genus *Porites*: the surface consists of a very large number of small calices with pentagonal thecal walls and no coenosteum between them. The substance of the corallum is therefore porous. It is only used occasionally, artificially

coloured, and made into small cylinders for necklaces, to imitate the blue coral (*Heliopora coerulea*).

Genus *Madrepora,* species *oculata*: it is known as « Mediterranean White Coral ». The material is subtranslucent and can be brilliantly polished. A section perpendicular to the axis of the colony shows numerous radiating bands meeting at a hub in the centre. A second fainter structure is made up of concentric circular lines. Some faint parallel strips (about mm 0.1 in width) are arranged along the branches.

Fig. 7. — *Diploastraea heliopora*: calices with large dentations surrounded by a cockade structure, 18 x.

Genus *Cyathelia*: this is known as « Japanese White Coral ». The material is opaque, with a ceramic-like appearance. Faint longitudinal strips are barely perceptible. A very faint concentric structure, made up of alternately white and very light pink layers, can be found in transverse section. Some minute pinkish-orange spots can be seen sparsely on the surface.

Genus *Diploastraea,* species *heliopora*: the surface, which can be suitable to good polishing, consists of a large number of calices, usually circular in outline, sometimes a little distorted with relatively large dentations (fig. 7). In transverse section they pass down into long cylindrical pores which resemble those of genus Heliopora. The peritheca exhibits a cockade-structure close to the calices which gradually changes into a series of thinner and thinner layers.

Order Zoanthinaria

In this order, only the members of the Gerardiidae family are provided with a skeleton, which is horny. They were sometimes confused with Antipatharia, whose skeleton is however different in composition and structure.

Genus *Gerardia,* species *savaglia*: this is known as « Mediterranean Black Coral ». The surface, in transverse section, exhibits a series of concentric lamellae of black horny substance, firmly cemented together (more than in Antipatharia). The centre of the axis exhibits a core of yellowish fibrous substance which is a stem of Gorgonarian (*Paramuricea*), covered with *Gerardia* in the early stage of its growth. The surface of the axis becomes smooth, but is shagreened by a number of small pitted mounds.

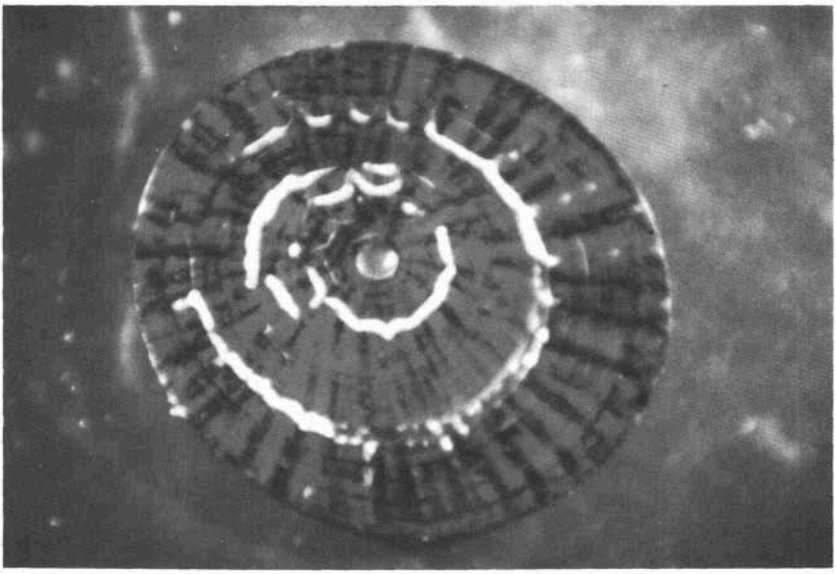

Fig. 8. — *Parantipathes larix*: radial structure and concentric layers in transverse section, about mm 0.72 thin, 7.2 x, crossed nichols.

Order Antipatharia

Members of this order resemble those of Gorgonaria (family Gorgoniidae) and Zoanthinaria (family Gerardiidae) in forming a black, hard, axial support, non-impregnated with calcareous matter. The organic substance of the axis however, belongs to the proteins which are very low in sulphur and cannot therefore be placed in the keratin group. This kind of protein has been called Antipathine.

Genus *Parantipathes,* species *larix*: the surface shows a number of distinct rounded thorn-like processes which can be seen to their best in translucent yellowish-brown areas below the surface. In section, perpendicular to the axis, a central circular cavity is to be found, around which the proteinous matter is arranged

in concentric layers not so firmly cemented together as in *Gerardia*. A thin section (about mm 0.72) shows a system of evident rays diverging from the central cavity and which are perpendicular to the concentric structure. This latter is made up of very wavy lamellae of proteinous substance, whose colour in transmitted light is brownish-red with a purple shade (fig. 8). The pleochroism varies from bright red to dark red. Wavy extinction. It is known as « Thorny Coral » or « Prickle Coral ».

TABLE 2

Physical data of gems from Cnidaria

GENERA AND SPECIES	COLOUR (-)	SPECIFIC GRAVITY (T=21 °C)	REFRACTION INDICES (Na_D) n_ε	n_ω	EFFECTS UNDER ULTRAVIOLET RAYS (365nm; 200W)
Stylaster	6:3.5:2	2.60	1.500	1.650	pinkish-violet glow
Allopora nobilis	5:4.5:1 8:2.5:1 11:2:3	2.48	1.520	1.649	no glow in coloured areas; yellow glow in white areas
Tubipora musica	8:6:3	2.75	not measurable		purplish-violet glow
Heliopora coerulea	17:2:4	2.46	not measurable		violet glow with light blue spots
Corallium elatius	7:1:1 7:3:2	2.70	1.500	1.650	pinkish violet and white glow in layers
Corallium japonicum	7:5:3	2,63	1.500	1.650	purple glow with violet blobs
Corallium rubrum (red)	7:6:3	2.35-2.66	1.495	1.650	purplish-red orange glow
Corallium secundum	6:1.5:1	2.69	1.490	1.650	pinkish-violet glow
Melithaea ochracea	7.5:5:4.5	2.02	not measurable		purple glow with light blue and orangey-yellow areas
Plumarella	3:4:5	1.37	from 1.530	to 1.550(%)	faint yellowish-green glow; brown core
Gorgonia	3:3:6	1.33	from 1.540	to 1.560(%)	faint yellowish-green glow
Eunicella	3:3:6	1.33-1.37	from 1.540	to 1.550(%)	faint yellowish-green glow
Keratoisis	2:3:3.5	2.19	1.500	1.640	yellow glow with white core
Pocillopora	2:1:1	2,55	1.520	1.655	faint violet-white glow
Seriatopora	-:0:1	2.73	1.520	1.650	faint violet glow
Acropora	-:0:1	2.62	not measurable		violet-white glow
Fungia	2:1:1	2,78(theca)	1.520	1.650	bluish-white glow
Herpolitha	2:1:1.5	2.40	1.520	1.650	violet-white glow
Porites (art. coloured)	17:2:5	2.37	not measurable		violet glow
Madrepora oculata	2:1:1	2.71	1.500	1.650	bluish-white glow
Cyathelia	5:1:1	2.65	1.500	1.640	bluish-white glow
Diploastraea heliopora	15:1:1.5	2.64	not measurable		light violet glow
Gerardia savaglia	-:0:8	1.38-1.42	from 1.550	to 1.570(%)	greenish yellowish-violet glow
Parantipathes larix	4:1:8	1.35-1.37	from 1.560	to 1.570(%)	greenish-yellow glow

(-) According to DIN 6164 Colour System, by comparison under standardized light (D 65).

(%) These two refraction indices represent the limits between which it varies the single detectable value, the material being amorphous.

Note: effects under X-rays (anticathode W; 45 KV, 20 mA) are nil for all samples.

The previous descriptions greatly facilitate the distinction of class Hydrozoa gem corals from those belonging to the class Anthozoa and, in the latter case, the Octocorallia (or properly called corals) from the Hexacorallia (or madrepores or stony corals).

From a gemmological standpoint this distinction is of great importance.

In point for fact, amongst corals with a calcareous skeleton, Hydrozoa and Hexacorallia often need special treatment to obtain a high polish and in any case are less compact than the Octocorallia. *Corallium rubrum* belongs to the latter and is known as coral « par excellence », its quality is firstly due to its particular growth (the spicules are so well cemented together that there are no inter-spaces) which makes it more compact and translucent and secondly to its wide range of colour shades, amongst which a pale shade of pink with a bluish tinge is to be found and is known as « Angel-skin » (also to be found in *Corallium elatius*, characterized however by quite another structure).

Study of the surface structures is therefore necessary in order to distinguish *Corallium rubrum* from corals of Japanese origin and, what is more important, from dyed madrepore (*Madrepora oculata*). Colour distribution in this case assumes a diagnostic importance; in *Corallium rubrum* colour is not uniform, innumerable microscopic dots are to be found on a homogeneous base. The dots vary from a pinkish-orange to a dark red colour. Physical data (mainly specific gravity, which is higher in *Madrepora oculata*) complete identification.

Amongst the genera with a horny or proteinous skeleton, all those belonging to the class Anthozoa, the Hexacorallia (*Gerardia savaglia* and *Parantipathes larix*) are more compact and suitable for processing. They are however of lower quality than corals with a carbonate composition (mainly aragonite) and it is therefore important to specify whether a calcareous, horny or proteinous skeleton is being dealt with when certifying, without having to resort to destruction of the sample.

TABLE 3
Origin of samples used in research

SAMPLES	ORIGINS
Stylaster	Mediterranean Sea, near Africa
Allopora nobilis	Agulhas Bank, Cape of Good Hope (South Africa)
Tubipora musica	Philippine Islands
Heliopora coerulea	Philippine Islands
Corallium elatius	Japan
Corallium elatius (Angel-skin)	Tche Li Gulf (China and Vietnam)
Corallium japonicum	Japan
Corallium rubrum	Mediterranean Sea
Corallium secundum	Japan
Melithaea ochracea	Philippine Islands
Plumarella	Japan
Gorgonia	Indian Ocean and Philippine Islands
Eunicella	Mediterranean Sea
Keratoisis	Philippine Islands
Pocillopora	Philippine Islands
Seriatopora	Philippine Islands
Acropora	Philippine Islands
Fungia	Philippine Islands
Herpolitha	Philippine Islands
Porites	Philippine Islands
Madrepora oculata	Mediterranean Sea
Cyathelia	Midway Islands (Hawaii Islands)
Diploastraea heliopora	Philippine Islands
Gerardia savaglia	Mediterranean Sea
Parantipathes larix	Philippine Islands and Red Sea

Knowledge of the gemmological characteristics of the materials from Cnidaria is therefore essential for their identification.

The general picture of the surface structure of gem corals previously illustrated together with their physical characteristics permits identification of all samples to be found on the market at the present moment and any eventual treatment.

For the sake of brevity and expediency physical data of all samples have been grouped in table 2. Each specimen has been colour tested in standard light (D65) according to the DIN 6164 Colour System, and specific gravity, refraction indices (Na_D), and luminescent effects by ultraviolet and X-rays have been taken into consideration.

The origins of samples used in this research have been grouped in table 3.

Conclusions

In gem testing, normal procedure is firstly characterized by observing the surface structure (in translucent gems) and the internal features (in transparent gems) and, secondly, by taking physical data into consideration.

Diagnosis is held as certain, when all structural and physical characteristics coincide.

On termination of a gemmological analysis and having a complete description of the gem under examination, it is possible to ascribe any type of coral to be

found on the market today to one of the genera and species of Cnidaria through comparison with the listed structures and relative data. The most important result is that of excluding from this phylum and at the same time from corals considered in a broad or commercial sense those materials not presenting the described structures and, contemporarily, relative data.

The possibility of the skeleton of another genera as yet unknown being used as a gem in the future is not to be excluded, or that some skeletons actually unsuitable for cutting and processing can become so after opportune treatment. As there is no practical use at the moment, they have obviously not been included in the lists of this review. It would be extremely difficult however for new types to have completely different characteristics (thereby inducing the gemmologist to come to a wrong analysis result).

More than likely some of the characteristics of the genera or of the already known species will be present. In this case, more consideration will have to be taken expecially if the colour of the samples does not agree with those already known. In point of fact there is the bad habit of artificially changing the colour of gem materials. This leads the analyst to suspect any colour however authentic it may be, if it is not well known.

This argument, vast in its own rights and worth investigation, cannot be dealt with quickly and lightly. It would have to be dealt with separately and does not come within the limits of this research which is based on the study of the characteristics of gem-materials originating from Cnidaria in a natural state.

Acknowledgments. — The Author wishes to express her thanks to Dr. MARGHERITA SUPERCHI - Servizio Pubblico di Controllo per le Pietre Preziose e le Perle della Camera di Commercio di Milano, Italia - for critical revision of the paper; to Prof. Dr. LUCIA ROSSI - Istituto di Zoologia, Università di Torino, Italia - for advice and help in classifying Cnidaria; to Mr. H. S. PIENAAR, F.G.A. - Gemmology Section, Department of Geology, University of Stellenbosch, Republic of South Africa, through whom she was able to obtain the samples of Allopora nobilis from Messrs. Transvaal Tigerseye Industries (Pty), Ltd., Johannesburg.

REFERENCES

BARNES R. D. (1972) - *Zoologia: gli invertebrati,* tradotto da R. Milani, Piccin Editore, Padova.

BAUER M. (1969) - *Precious Stones,* translated from the German with additions by L. J. Spencer, Charles E. Tuttle Co., Rutland, Vermont & Tokyo, Japan.

BROWN G. (1977) - *Black Coral: True or False.* The Australian Gemmologist, may, 35-41.

CAVENAGO-BIGNAMI MONETA S. (1980) - *Gemmologia.* IV Ed., Ulrico Hoepli Editore, Milano.

EPPLER W. F. (1973) - *Praktische Gemmologie.* Rühle Diebener Verlag KG, Stuttgart-Degerloch.

HYMAN L. H. (1940) - *The invertebrates: Protozoa through Ctenofora.* McGraw Hill Book Co., Inc., New York & London.

KÜKENTHAL W. (1923-1925) - *Handbuch der Zoologie.* Walter de Gruyter Verlag, Berlin und Leipzig.

La Greca M. (1977) - *Zoologia degli invertebrati.* UTET, Torino.
More R. C. (1956) - *Treatise on Invertebrate Paleontology,* pt. F. *Coelenterata.* Geol. Soc. of America, University of Kansas Press.
Ove D. (1972) - *Edelsteine in Farben.* Universitas Verlag, Berlin.
Parker J., Haswell W. A. (1957) - *A Text Book of Zoology.* Revised by O. Loewenstein, Vol. I, VI Ed., Macmillan & Co., Ltd., London, New York, St. Martin's Press.
Pienaar H. S. (1981) - *African Star Coral, a New Precious Stylasterine Coral from the Agulhas Bank, South Africa.* The Journal of Gemmology, XVII, 8.
Rossi L. (1971) - *Guida a Cnidari e Ctenofori della fauna italiana.* Quad. Civ. Staz. Idrobiol. Milano, 2.
Schlossmacher K. (1969) - *Edelsteine und Perlen.* E. Schweizerbart'sche Verlagsbuchhandlung, Stuttgart.
Smith G. F. H. (1972) - *Gemstones.* Revised by F. C. Phillips, IV Ed. Chapman and Hall, London.
Superchi M. (1978) - *La Gemmologia come scienza accademica a sé stante, non una parte della mineralogia: principi generali e concetti.* Rend. SIMP, 35 (1), 199-215.
Sydney J. H. (1924) - *An Introduction to the Study of Recent Corals.* Manchester: at the University Press, Longmans, Green & Co., London, New York.
Webster R. (1970) - *Gems: Their Sources, Descriptions and Identification.* II Ed., Butterworth & Co. (Publishers) Ltd., London.