

**'SPONGUIDE'. GUIDE TO SPONGE COLLECTION AND IDENTIFICATION  
(Version 2003)**

*John N.A. Hooper. Queensland Museum, PO Box 3300, SOUTH BRISBANE, QLD, 4101, Australia  
(email: John.Hooper@qm.qld.gov.au).*

**FOREWARD**

This sponge identification guide is an ongoing project of the Queensland Museum. It was originally conceived as a response to an overload of requests for sponge identifications, particularly from the professional community. Diagnoses of many genera are still incomplete, which would take several more years to accomplish. In any case, this guide has now been superseded by the more comprehensive 'Systema Porifera', a collaborative project amongst over 40 sponge biologists to publish the supraspecific classification of living and fossil sponges, providing a sound baseline for higher systematics debate and a bench document for routine classification (HOOPER, J.N.A. & SOEST, R.W.M. VAN (eds) 2002. *Systema Porifera. A Guide to the classification of sponges* Vols 1&2, xlviii 1708pp (Kluwer Academic/ Plenum Publishers: New York, Boston, Dordrecht, London, Moscow). (<http://www.springer.com/life+sci/zoology/book/978-0-306-47260-2>). The main intention in distributing the current Spongguide is to encourage other scientists to undertake at least some level of standard preparation and identification (i.e. taxonomic sorting) of their material prior to sending it to us or others for further identification, to make our lives a little bit easier.

There are no original illustrations included in this version, and for the time being the Spongguide should be used in conjunction with the recommended references listed at the end of the document which contain some relevant illustrations.

**CONTENTS**

0. List of sponge higher taxa.
1. Introduction to sponges
2. Methods of dealing with sponges in the laboratory and preparation for their identification.
3. Outline of characters used for Demospongiae identification.
4. Major characters used to describe the Demospongiae, based on the 'DELTA' (CSIRO computerised descriptions) format.
5. Key to the extant orders of Porifera.
7. The sponge classification (extant taxa only).
8. Preferred format for sponge samples sent for identification.
9. Recommended reading
10. Glossary.
11. Illustrations.
12. Index to genera of extant Porifera.

**LIST OF SPONGE HIGHER TAXA**

<b>PHYLUM PORIFERA</b>	Spongiidae Gray, 1867 Thorectidae Bergquist, 1978
<b>CLASS ARCHAEOCYATHA (extinct)</b>	
<b>CLASS: DEMOSPONGIAE</b>	<b>ORDER: HALICHONDRIDA</b> Axinellidae Carter, 1875 Bubaridae Topsent, 1894 Desmoxiidae Hallmann, 1917 Dictyonellidae Van Soest, Diaz & Pomponi, 1990 Halichondriidae Gray, 1867
<b>SUBCLASS: HOMOSCLEROMORPHA</b>	
<b>ORDER: HOMOSCLEROPHORIDA</b> Plakinidae Schulze, 1880	
<b>SUBCLASS: CERACTINOMORPHA</b>	
<b>ORDER: AGELASIDA</b> Agelasidae Hartman, 1980 Astroscleridae Lister, 1900	<b>ORDER: HALISARCIDA</b> Halisarcidae Schmidt, 1862
<b>ORDER: DENDROCERATIDA</b> Darwinellidae Merejkowsky, 1879 Dictyodendrillidae Bergquist, 1980	<b>ORDER: HAPLOSCLERIDA</b> <b>SUBORDER: HAPLOSCLERINA</b> Callyspongiidae de Laubenfels, 1936 Chalinidae Gray, 1867 Niphatidae Van Soest, 1980
<b>ORDER: DICTYOCERATIDA</b> Dysideidae Gray, 1867 Irciniidae Gray, 1867	<b>SUBORDER: PETROSINA</b> Petrosiidae Van Soest, 1980 Phloeodictyidae Carter, 1882

SUBORDER: SPONGILLINA  
Metaniidae Volkmer-Ribeiro, 1986  
Spongillidae Gray, 1867

ORDER: POECILOSCLERIDA  
SUBORDER: LATRUNCULINA  
Latrunculiidae Topsent, 1922

SUBORDER: MICROCIONINA  
Acanthidae Dendy, 1922  
Microcionidae Carter, 1875  
Raspailiidae Hentschel, 1923  
Rhabderemiidae Topsent, 1928  
SUBORDER: MYCALINA  
Cladorhizidae de Laubenfels, 1936  
Desmacellidae Ridley & Dendy, 1886  
Esperiopsidae Hentschel, 1923  
Guitarridae Dendy, 1924  
Isodictyidae Dendy, 1924  
Mycalidae Lundbeck, 1905  
Podospongiidae de Laubenfels, 1936

SUBORDER: MYXILLINA  
Chondropsidae Carter, 1886  
Coelosphaeridae Dendy, 1922  
Crambeidae Lévi, 1963  
Crellidae Dendy, 1922  
Dendoricellidae Hentschel, 1923  
Desmacididae Schmidt, 1870  
Hymedesmiidae Topsent, 1928  
Iotrochotidae Dendy, 1922  
Myxillidae Dendy, 1922  
Phellodermidae Van Soest & Hajdu, 2002  
Tedaniidae Ridley & Dendy, 1886

ORDER: VERONGIDA  
Aplysinellidae Bergquist, 1980  
Aplysinidae Carter, 1875  
Ianthellidae Hyatt, 1875  
Pseudoceratinidae Carter, 1885

ORDER: VERTICILLITIDA  
Verticillitidae Steinmann, 1882

SUBCLASS: TETRACTINOMORPHA  
ORDER: ASTROPHORIDA  
Ancorinidae Schmidt, 1870  
Geodiidae Gray, 1867  
Pachastrellidae Carter, 1875

ORDER: CHONDROSIDA  
Chondrillidae Gray, 1872

ORDER: HADROMERIDA  
Acanthochaetetidae Fischer, 1970  
Alectonidae Rosell, 1996  
Clionidae D'Orbigny, 1851  
Hemiasterellidae Lendenfeld, 1889  
Placospongiidae Gray, 1867  
Polymastiidae Gray, 1867  
Sollasellidae Lendenfeld, 1887

Spirastrellidae Ridley & Dendy, 1886  
Stylocordylidae Topsent, 1928  
Suberitidae Schmidt, 1870  
Tethyidae Gray, 1867  
Timeidae Topsent, 1928  
Trachycladidae Hallmann, 1917

ORDER: LITHISTIDA  
Desmanthidae Topsent, 1894  
Theonellidae Lendenfeld, 1903

ORDER: SPIROPHORIDA  
Samidae Sollas, 1888  
Tetillidae Sollas, 1886

### CLASS: CALCAREA

ORDER: BAERIDA  
Baeriidae Borojevic, Boury-Esnault & Vacelet, 2000

ORDER: CLATHRINIDA  
Clathrinidae Minchin, 1900  
Leucaltidae Dendy & Row, 1913  
Leucascidae Dendy, 1892  
Leucettidae de Laubenfels, 1936  
Levinellidae Borojevic & Boury-Esnault, 1986  
Soleniscidae Borojevic, Boury-Esnault & Vacelet, 1990

ORDER: LEUCOSOLENIIDA  
Achromorphidae Borojevic, Boury-Esnault, Manuel & Vacelet, 2002  
Amphoriscidae Dendy, 1892  
Grantiidae Dendy, 1892  
Heteropiidae Dendy, 1892  
Jenkinidae Borojevic, Boury-Esnault & Vacelet, 2000  
Lelapiidae Dendy & Row, 1913  
Leucosoleniidae Minchin, 1900  
Sycettidae Dendy, 1892

ORDER: LITHONIDA  
Minchinellidae Dendy & Row, 1913

### CLASS: HEXACTINELLIDA

ORDER: AMPHIDISCOPHORA  
SUBORDER: AMPHIDISCOSIDA  
Hyalonematidae Gray, 1857  
Monorhaphididae Ijima, 1927  
Phoronematidae Gray, 1870

ORDER: HEXASTEROPHORA  
SUBORDER: AULOCALYCOIDA

Aulocalycidae Ijima, 1927  
SUBORDER: HEXACTINOSIDA  
Euretidae Zittel, 1877  
Farreidae Gray, 1872  
SUBORDER: LYCHNISCOSIDA

Aulocystidae Sollas, 1887  
SUBORDER: LYSSACINOSIDA  
Euplectellidae Gray, 1867  
Rossellidae Gray, 1872

## 1. INTRODUCTION TO SPONGES

### □WHAT ARE SPONGES ?

Sponges are the most primitive of multicellular **animals** (metazoa). They have:

- A cellular grade of construction without true tissues; body plans range from simple (asconoid, syconoid) through to complex (leuconoid) produced by varying degrees of infolding of the body wall and complexity of water canals throughout the sponge;
- Adults are asymmetrical or radially symmetrical.
- They are exclusively aquatic (water dwelling), most **marine**, found from deepest oceans to the edge of the sea.
- They play such **important roles** in so many marine habitats but we still know very little about their diversity, biology and ecology as compared with most other animal groups. In many benthic (sea bottom) habitats sponges are often the dominant animals.
- They have evolved an amazing range of **growth forms**, best described as highly irregular and sometimes completely plastic, frequently altered by prevailing external conditions (currents, turbidity, salinity etc.). Sponges also have evolved an amazing array of **colours** (possibly linked to photoprotection ?)
- Adults are **sedentary** (sessile), attached to the seabed or other substrate for most of their lives, although many have larvae that motile, swimming or crawling away from their parent.
- They have **sexes** that are separate, or sequentially hermaphroditic, although most population dispersal and recruitment is asexual (through budding, fragmentation from storm events, etc).
- Larvae are motile, incubated within the parent or broadcast into the seawater: parenchymella (solid, ciliated), amphiblastula (central cavity).
- They **filter** sea water to eat, breath and excrete waste products. Sponges often have complex water canal systems running throughout the body, with smaller inhalant (ostia) and larger exhalant pores (oscles). Sponges are able to actively pump up to 10 times their body volume each hour, making them the most efficient vacuum cleaners of the sea.
- They appear to be very stable, **long-lived** animals, although growth rates vary enormously between different groups. Some sponges, like haplosclerids can grow centimetres in weeks, and may have shorter life spans. Others sponges, like the living fossil 'sclerosponges' are VERY slow growing, with the largest known individuals (up to 30cm diameter) thought to be around 5,000 years old (which makes them the oldest living individuals on the planet, if this is true !).

Sponges are a **unique** group of animals because:

- They have unique collar-cells (**choanocytes**) which are surrounded by cilia with a central flagellum that moves to actively create a current pulling water in and out of the sponge. These collar cells line the walls of small chambers throughout the water vascular system. There may be 7,000-18,000 of these chambers per cubic millimeter of sponge, and each chamber may pump approximately 1,200 times its own volume of water per day !
- They have **no tissues or sensory organs** but they do have MANY different types of cells with MANY different functions that carry out normal bodily routines, including a primitive cell type (called an archaeocyte, an amoeboid-like cell) that is **totipotent** (able to change functions as required by the sponge [e.g. secrete the skeleton, form the epidermis, become feeding and reproductive cells etc.]).

- The outer and inner layers of cells (exopinacocytes, basipinacocytes) ("the skin") lack a basement membrane; middle layer.(mesohyl) is variable but always includes motile cells and usually some skeletal material.
- A mineral skeleton is present in most (but not all) groups of sponges composed of calcium carbonate, silicon dioxide, and/or collagen fibres.
- Skeletal elements (**spicules**) are diverse in their geometry and size.
- Sponges are **individuals**, having a continuous "skin" (epithelium) that contains roving cells inside; they are not colonies (like corals and sea-squirts in which individuals animals group together).
- Sponges catch, eat, digest their food and excrete their waste products **within cells**, not within any common body cavity, unlike most multicellular animals.
- Some sponges (particularly those growing on coral reefs) have a unique symbiosis with **cyanobacteria** not found in any multicellular animal. These cyanobacteria (or blue-green algae) provide the sponge with nutrients from photosynthesis to supplement those obtained by the sponge from normal filter feeding activities. These extra nutrients greatly augments sponge growth rate and competitive ability in coral reef systems.

## 2. METHODS OF DEALING WITH SPONGES IN THE LABORATORY AND PREPARATION FOR THEIR IDENTIFICATION.

### □ 2.1. Collection.

Sponges are often soft bodied, many are fragile and colours are generally unstable (e.g. aerophobic, soluble). Many sponges are also harmful to humans, producing physical damage (e.g. from sharp spicules protruding through the surface) and/or with an irritating mucus and other chemicals, sometimes causing severe dermatitis. Consequently, special care must be taken when collecting to minimise damage to both the sponge and collector. Sponges may be removed from the substrate with a knife or chisel, preferably using protective gloves and protective clothing.

Collections of sponges intended for identification should be accompanied by *in situ* photographs and adequate documentation (locality, habitat, surface features, colour notes etc.). In many species both colouration and morphology may change dramatically following collection and preservation, and identifications, even by specialists, are often greatly facilitated if there are adequate colour photographs of live material.

### □ 2.2. Fixation and preservation.

Sponges should be frozen immediately upon collection, which to a certain extent fixes the colour, or live material may be placed directly in 80-90% ethanol solution. A 5% concentration of buffered formaldehyde is a less preferable alternative for fixation, and should be used for only brief periods (e.g. 24 hours), after which specimens should be transferred immediately to ethanol. Calcareous sponges should not be fixed or preserved in formalin.

Sponges may also be air dried in the sun, although many may lose their shape, most lose their colouration (but few lose their noxious smell!). For several groups of sponges (i.e. those which have strong fibre skeletons such as the commercial 'bath sponges'), specimens may be rotted in freshwater and subsequently washed in solutions of potassium permanganate and then sodium metabisulphide. This technique softens and cleans the fibrous skeleton from incorporated sand particles.

### □ 2.3. Histological preparation for light microscopy.

Usually sponge identifications require two forms of histological preparation: one, a **spicule** preparation (for those species with a mineral skeleton), to determine the diversity and geometry of spicules in the skeleton; and a second, a perpendicular section though the sponge 'tissue', to determine the structure of the skeleton, the **water-canal system**, and other aspects of histology.

2.3.1. **Spicule preparations.** For spicule preparations several simple methods are available, none of which requires extensive experience or sophisticated equipment.

2.3.1.1. **Bleach digestion.** This technique is useful for rapid surveys of spicules within a sponge, although preparations are not as clean as those obtained through an acid digestion process. Sponges with calcareous spicules are routinely prepared in this manner. Small fragments of 'tissue', including fragments from both the surface and deeper parts of the sponge, are placed in small Erlenmeyer flasks

or directly on microscope glass slides. A small quantity of active bleach (sodium hypochlorite) is added to the fragment, and after a short period the organic components dissolve leaving only the mineral skeleton. The bleach must then be carefully diluted and eventually washed out of tissues several times, replaced firstly with water and then with ethanol. If bleach is not completely removed preparations become crystalline. Finally, clean spicule suspensions are aspirated and pipetted onto a glass slide, the ethanol allowed to evaporate, and mounted. It is important to note that during each stage of pipette wash the suspension should be left to settle for about 10-15 minutes, prior to decanting the supernatant, to avoid accidental decanting of smaller spicules. Using flasks for the actual digestion process, instead of slides, has the advantage that a centrifuge can be used to eliminate the settling time of the supernatant. Conversely, preparations made directly on slides have the advantage that spicules do not have to be pipetted, and hence minimising the potential for losing the smaller spicules.

**2.3.1.2. Acid digestion.** This technique provides cleaner, permanent preparations, but the process involves noxious chemicals and should be undertaken only with suitable facilities (e.g. protective clothing, fume extraction). This process uses nitric acid instead of bleach. Fragments of sponge are placed in flasks, directly on glass slides, or directly on electron microscope stubs. Several drops of acid are placed on the fragment, gently heated over a flame until bubbling, and repeated until all organic matter is digested (this is easily ascertained by eye). The heat-accelerated digestion process produces various oxides, including nitrous oxide, and it is cautioned that these are noxious. It should also be noted that the acid is evaporated rather than burnt, so low heat is preferable (e.g. using an alcohol flame rather than gas). Once dry and cool, preparations can be mounted immediately without washing. Siliceous spicules are bonded directly onto the substrate by this technique, which makes it useful for both light and scanning electron microscopy.

Spicule preparations obtained from both techniques are now ready for covering using a suitable mounting medium (e.g. Depex, Canada balsam, Euparal, Durcupon, etc.).

**2.3.2. Section preparations.** For sponge sections there are more complex procedures involved, using microtome-sectioning or at least thick, hand-cut sections. The object of these techniques is to observe skeletal structures and cytological characteristics as much as they appear in the live animal, so wax embedding techniques, staining and/or simple clearing agents are required. Several techniques are available, most requiring specialist histological facilities.

**2.3.2.1. Simple clearing.** The easiest method to determine the structure of the mineral skeleton is to using thick hand-cut sections cleared in a clearing agent (e.g. toluene, xylene, phenol-xylene, Histosol, HistoClear, lactophenol creosote, etc.). A perpendicular section through the surface and deeper skeleton is cut from a larger, preserved fragment of sponge by hand, using a new, clean scalpel. Relatively even, thick sections (between 50-100µm thickness) are possible using hand-cutting techniques, but success is certainly linked with practice. Cut sections are placed directly in a saturated mixture of phenol and xylene (matured for at least 1 week) to clear the section, which eliminates the need for an alcohol dehydration series. Clearing may take between 4-24 hours, depending on the development of collagen in the species. Cleared sections can be mounted directly on slides, but cover glasses should be supported with glass slivers or card on thick sections.

**2.3.2.2. Wax embedding.** To produce a perfectly uniform section thickness, and for thin sections, wax embedding and microtome techniques are required. Fragments of preserved sponges should be passed through a dehydration series, cleared in toluene, and wax embedded for at least 2 hours. Alternatively, fixed samples can be processed directly in an automated paraffin embedding system, such as Tissue Tek V.I.P. 2000, on a 16-48 hour cycle. Sections should be cut from trimmed wax blocks, cutting from the centre of the block to the exterior so as to include both the outer surface and inner skeleton relatively intact. For most species relatively thick sections are required (>50µm), so as to avoid breaking the spicules *in situ*, but for 'keratose' (non-spiculous) sponges thinner sections are preferable. Cut sections are placed in clearing agent for an adequate period to dissolve wax and clear the 'tissue', then soaked in ethanol (perhaps clearing and dehydrating several times until perfectly clear, and/or dewaxing on a hot plate), floated onto slides, orientated and flattened, and mounted.

**2.3.2.3. Staining.** Staining as a technique for sponge histology is not a widespread procedure given that taxonomy of most groups is based on the inert silicon (or calcareous) skeleton. For some groups, such as the 'keratose' sponges, or where histological information is required, staining such as Mallory Heidenhain's solution is useful. Sections are processed, wax embedded, cut and placed on slides as described above. Sections placed on albumen coated slides are drained and dried at 60°C, dewaxed in xylol for at least 5 minutes, hydrated through an alcohol series to water, stained in Mallory Heidenhain for 7 minutes, dipped in tap water 6 times, dehydrated in an alcohol series, cleared in xylol and mounted.

#### □ 2.4. Histological preparation for scanning electron microscopy.

Much of the preparation outlined below involves hazardous chemicals and noxious fumes, and certain safety precautions should be taken (laboratory coat, gloves, safety glasses, eye-wash bottle handy,

fume extraction system). Similarly, it essential that instruments used to prepare SEM preparations are thoroughly cleaned to prevent contaminants from being introduced.

#### 2.4.1. Section preparation and viewing.

1. Cut a 1-1.5mm thick section of sponge ensuring that both the ectosome and choanosome are represented. Cut another similar section for later use in spicule preparation.
2. Place section in cavity block and cover with several drops of sodium hypochlorite (household bleach) to etch the collagen from the skeleton. Monitor the etching process through a dissecting microscope in order to prevent the skeleton falling apart. Delicate structures (plumose, halichondroid, hymedesmoid skeletons) may only require a few seconds treatment with bleach; robust skeletons (reticulate, fibrous, articulated skeletons) may several minutes; generally 30 seconds is adequate time in bleach.
3. Pipette off bleach at the appropriate time and immediately add 70% ethanol. Leave stand for several minutes to ensure bleach is completely neutralised.
4. Omit this step if section is very delicate. Without removing section from cavity block, repeat steps 2-3 substituting concentrated hydrogen peroxide in place of sodium hypochlorite (bleach). Finally rinse in ethanol.
5. Place section on clean microscope slide and let dry.
6. Mount section on SEM stub with double-sided tape, copper dag, or Superglue. An alternative method of fixing sample to stub, and one that produces a perfectly smooth background, is to cover stubs with "Aquadhere" wood glue, let dry completely (usually several days), then prior to use expose dried glue to vigorous steam (e.g. boiling kettle), which softens the set glue, and simply place the section on top of the stub (it sinks in a short way but is bonded reasonably well to stub).
7. Sputter-coat the specimen well to ensure that all fibres are well coated. In some cases uncoated sections can be viewed successfully under low accelerator voltage, but better results are generally obtained on coated specimens at higher voltage. Typical viewing conditions are 25kV, at small working distances to provide best depth of field and focus, and at low magnifications.

#### 2.4.2. Spicule preparation and viewing.

1. Take a thinly cut section (including both ectosome and choanosomal regions) and place in a durham tube (micro-test tube). Using a clothes peg or similar device to hold the tube add a drop of concentrated nitric acid to the tube (with opening pointed away from the face).
2. Wait for the vigorous reaction to finish and add another drop of acid. Repeat this step several more times, using drop-by-drop addition so as to control the reaction and production of oxide by-products.
3. After the acid digestion process appears to be complete, add enough nitric acid to nearly fill the tube. Directing the tube away from the face gently heat it over low heat (e.g. an alcohol flame), ensuring that only small bubbles form but not boiling rapidly. Maintain low boiling for 1-2 minutes and let stand until cool.
4. Centrifuge (4000rpm for 30 seconds is adequate).
5. Pipette off nitric acid leaving the spicule mass at the bottom of the tube undisturbed.
6. Refill the tube with fresh nitric acid and resuspend the spicules using clean, fine, glass rod.
7. Repeat steps 3-5.
8. Fill the tube with firstly demineralised water, 70% ethanol, then two series of 100% ethanol solutions, resuspending spicules, centrifuging and decanting the supernatant between each change of solution, finally ending with suspended spicules in a solution of absolute ethanol.
9. Adhere a micro-cover glass onto an SEM stub using double-sided tap or copper dag; place stub in stub holder.
10. Pipette a couple of drops of spicule solution onto the cover glass, ignite and spread out spicule solution with a glass rod or forceps until all ethanol is vaporised. Spicules bond to glass relatively firmly, but excess spicules can be blown off glass using compressed air, or spread out over the glass by adding further ethanol. Monitor the distribution of spicules on the cover glass under compound or dissecting microscope (magnification depending on spicule size). Add more drops of spicule solution and repeat this step if too few spicules are present, but do not overcrowd field of view for photographic purposes.
11. The alternative method of coating the stub with "Aquadhere" glue can also be used, although ethanol should not be burnt but evaporated, however, single spicules may sink into glue too far if it is too soft (left in steam too long).
11. Sputter coat stub, and view at 25kV, minimum working distance and smallest apperture for best resolution.

### 3. OUTLINE OF CHARACTERS USED FOR DEMOSPONGIAE IDENTIFICATION.

☐ Sponge identifications are primarily based on morphology. Some of these morphological characters vary substantially between widely separated populations, or those living in different habitats, indicating

no more than ecophenotypic variation within the species, whereas other features are much more consistent between individuals irrespective of their geographic distribution. Unfortunately, however, we are still not completely sure which of these 'variable characters' indicate population variability within a single species and which are consistent in the evolution of species, and thus are more important in sponge taxonomy. Over recent years many new non-morphological characters have been discovered from genetic, biochemical and ultrastructural studies of sponges. Some of these characters have been useful in supporting or refuting current ideas on morphological-based sponge taxonomy, but in other instances it is difficult to find any morphological characters that correspond to these new schemes: ultimately taxonomy must somehow be related to the morphology to be of practical value.

Consequently, most sponges are not easy to identify, even for experts, requiring specialised techniques. Some of these techniques are outlined below, including the preferred methods for collection, documentation, histological preparation, and a brief explanation of many of the features used to identify sponges.

### □ 3.1. Brief summary of sponge morphology.

A simple analogy of a sponge is a flexible balloon containing a gelatinous ground substance, a roving cell population, water canals and water pumping stations, and organic and/or inorganic structures producing a definite body form. The 'simple sponge' is in fact a very complex histological unit, which even today is not well understood. For the present purposes of sponge identification we provide here a brief outline of the main structural features of two of the three classes of Porifera (the Hexactinellida, a deep water group known as glass sponges, is substantially different and not dealt with here). More thorough, detailed sources of reference are provided at the end of this book.

The sponge is bounded on the exterior surface by a unicellular layer (**exopinacoderm**), called the **ectosome**, composed of special epithelial cells (**pinacocytes**). Some of these epithelial cells form small external pores (**ostia**) through which the water passes into the sponge, and others form larger pores (**oscles**) through which water is expelled. Internally (called the **choanosome**) the sponge is excavated by water current canals, also lined by a single layer of cells (**porocytes**) forming the **endopinacoderm**. 'Water pumping stations' (**choanocyte chambers**) are found at certain locations along the water canals, lined by special collar cells with a flagellum (**choanocytes**), unique to the Porifera. A water current is created by the beating of choanocyte flagella. Water is actively pumped through the water filtration system, through a series of sieves or filters of diminishing size, which serve to extract nutrients and oxygen from the incoming water. Similarly, waste products are expelled into the excurrent canals and jettisoned through the oscles. For the Calcarea the development of the water current system, from simple to complex (**asconoid**, **syconoid**, **leuconoid**), is important in its taxonomy, whereas in the Demospongiae most are of the complex (leuconoid) construction.

The living 'tissue' bounded on all sides by the pinacoderm is called the **mesohyl**. This contains a matrix or ground substance composed of a striated protein called **collagen**, an organic skeleton composed of **spongin fibres**, and/or an inorganic skeleton composed of mineral **spicules**. Within this mesohyl are found roving totipotent cells, capable of changing function as required. These include generalised amoebocytic 'stock' cells (**archaeocytes**), as well as many other types that have become specialised to carry out particular functions within the sponge, such as producing fibres (**collencytes**), secreting spicules (**sclerocytes**), contractile cells around excurrent pores or **oscles** (**myocytes**), and so on. There are many sorts of cells in sponges and only few so far have a known function. Attempts have been made to use these cytological characters in a taxonomic framework but with limited success.

There are many morphological characters which can be used to aid in sponge identification including shape, distribution of surface pores, colour, ornamentation of the surface, texture, structure and composition of the organic skeleton and water canal system, and the structure, composition, size and geometry of the inorganic skeleton. In addition, several non-morphological features have proven useful practical tools in sponge taxonomy.

### □ 3.2. Major characters used in sponge identification.

3.2.1. **Shape.** Many sponges are thought to be morphologically plastic, with individuals and populations potentially differing widely in shape and colouration depending on a complex series of local environmental conditions. Intraspecific genetic differences (clines) are also associated with geographic range and populations, and thus shape (or **habitat**) is not a particularly reliable absolute descriptive character. However, this 'problem' is perhaps overemphasised in the literature, and in only few instances have species been shown to be truly polymorphic. Generally species' growth forms can be defined within reasonable limits, used with a certain degree of caution shape may be informative for particular species determinations. The range of possible shapes seen in sponges is enormous, extending from thin encrustations to massive volcano shapes, finger-like or whip-shapes, 'golf balls', fans and so on.

3.2.2. **Size.** The size to which particular specimens may grow may be influenced by several factors, such as the individual's age, the prevailing environmental conditions (current, sedimentation, light

availability, etc.) and of course particular species' genetic potentials. Some species are capable of growing into huge volcano shapes (e.g. *Xestospongia*) whereas other related species are merely thinly encrusting on dead coral (e.g. *Petrosia*). Size is more important as a descriptive taxonomic character, such as when comparing populations of particular species or comparing closely related (sibling) species, and is less important as an absolute taxonomic descriptor.

3.2.3. **Colour.** Certain groups of sponges (such as the Verongida), have peculiar pigments that darken upon contact with air (**aerophobic pigments**), and others (such as Mycalidae and Tedaniidae, order Poecilosclerida) produce a pigmented mucus that stains or irritates human skin. Some groups of sponges are characteristically brightly coloured (e.g. Microcionidae, order Poecilosclerida) whereas others are typically drab (e.g. Halichondriidae, order Halichondrida). These characters are often useful for field identifications, and therefore colour notes and/or colour photographs are now considered to be essential for accurate identification.

The range of sponge pigments is enormous, varying from drab, colourless forms (black, beige or white) to very colourful species (vibrant reds, greens, yellows and blues, etc.). Sponge colouration can often be attributed to the presence of particular carotenoid pigments, and because a large proportion of these pigments is obtained and modified from the diet, mainly from the plankton, there may be some slight variability between populations of particular species from different localities. In contrast, a few species are truly polychromatic, with individuals, sometimes growing side by side, showing dramatic differences in colouration. By and large, however, colouration is a useful descriptor for species identifications, and when used cautiously colour illustrations, as presented in this book, can be useful tools for field identifications.

As noted above, colour may be fixed to a certain extent in live material by freezing specimens prior to preserving them, but most sponge pigments are alcohol soluble and colouration will be leached out into the preserving fluid to a greater or lesser extent. Thus, care should be taken when preserving several species of sponges in the same container, particularly with the aerophobic verongids that tend to dye all other sponges a dark purple colour.

3.2.4. **Texture.** To an experienced field biologist sponge texture often provides good clues as to the nature of the skeleton and water-canal system inside. A sponge which is rubbery, compressible but difficult to tear or cut may contain no or few spicules but a well developed spongin fibre system (e.g. *Ircinia*); a sponge that is soft, friable and easily torn probably has both fibres and spicules reduced (e.g. *Haliclona*); one that has a hard, stony but easily crumpled texture may lack spongin fibres altogether but have a closely compacted spicule skeleton (e.g. *Petrosia*); sponges incorporating sand into the skeleton are also to a large extent brittle, easily crumbled and incompressible (e.g. *Chondropsis*); and sponges that are hard, incompressible, difficult to cut or break may lack spongin fibres but have interlocking spicules (**desmas**), and/or a dense surface crust of spicules (e.g. *Desmanthus*, *Geodia*). The permutations are diverse.

Similarly, the texture of a sponge, the degree to which it can be compressed, and whether it retains its shape after it has been removed from the water may provide a good indication of the histology and water-canal system (the size of choanocyte chambers, the development of the skeleton and mesohyl in relation to the size of water-canals and choanocyte chambers, and the density of the roving cell populations). These features are particularly useful as both field and laboratory characters for the orders Dictyoceratida, Dendroceratida and Verongida (all of which lack a mineral skeleton).

3.2.5. **Mucus production and smell.** Many sponges produce mucus: usually clear, sometimes pigmented, and in many cases toxic or irritating to the human skin. This feature is certainly characteristic for particular species (e.g. *Aplysilla sulphurea*), sometimes characteristic for a particular genus (e.g. *Thorectandra*), but rarely consistent at the family level (e.g. Desmacellidae, with the well known toxic sponges *Neofibularia* and *Biemna*). Mucus production is particularly common in intertidal tropical species and may serve a physiological role in protecting (e.g. cooling) the sponge when exposed to the sun and air. Certainly some sponges literally drip mucus when exposed to the sun during low tides (e.g. *Clathria*), but probably more importantly mucus production may protect or even repel competing species, predators and parasites.

With experience a field biologist may also be able to recognise particular chemical smells emitted by particular species of sponges. Not many of these aromas have yet been documented, nor has this feature yet been quantified, but there are several groups of species that do have unique aromas (e.g. acrid smell of *Ircinia*, pungent smell of *Xestospongia*).

3.2.6. **Surface ornamentation.** The presence and distribution of surface pores, ridges, microconules, stalks, digits, protruding spicules and other processes are often important descriptive characters, and sometimes useful features in recognising particular genera. Small inhalant surface pores (ostia) may be confined to one side of the sponge (**inhalant surface**), with the larger exhalant pores (oscles) only on the other side (**exhalant surface**). This is sometimes seen in vase- or cup-shaped species (e.g.



*Xestospongia*). Similarly, the oscules may be scattered or aggregated into clusters (**sieve-plates** or **porocalyces**), raised on stalks (**fistules**) or flat against the surface. Exhalant pores often have a surrounding membrane lip, which may or may not be contractile, with or without subsurface drainage canals radiating away from the pores (**astrorhizae**).

Surface microconules, ridges and undulations are common features in many groups, whereas some species have characteristic, more specialised surface processes (e.g. *Myrmekeioderma* with polygonal plates, producing a pineapple-like texture, and apical pore sieve-plates; *Aka* with large oscules on the ends of long fistules poking through the substrate; many *Clathria* with astrorhizae radiating from oscules; *Callyspongia* and *Dysidea* with a cobweb-like surface ornamentation composed of spicules or sand, respectively).

**3.2.7. Organic and inorganic skeletons.** To provide a structure for the roving cell populations inside the sponge, the small choanocyte water pumps, and the water-canals themselves there are often two type of skeleton present, both of which are secreted by specialised sponge cells:

3.2.7.1. An organic (**spongin fibre**) skeleton, composed of collagen, usually forming strands. The construction of the fibres themselves, the patterns they form, and the material contained within the fibres are important characters used in classification.

3.2.7.2. An inorganic (**spicule**) mineral skeleton, found within and outside spongin fibres. Spicules are constructed of either opaline silica or calcite, and the shape, ornamentation, size, origin and arrangement of these spicules inside the sponge are also important characters used for classification.

**3.2.8. Foreign particles.** Many groups of sponges incorporate foreign particles into their mesohyl, particularly sand particles and spicules from other sponges, but also including shell debris from Foraminifera, Mollusca, Bryozoa, and filamentous algae. Foreign debris may be found inside spongin fibres, actively taken into fibres by a curious exchange process whereby in some species there is a complete loss of native spicules, replaced by debris. In other species foreign particles are found within the proteinaceous mesohyl of the sponge but only outside fibres, or they may be restricted to the exterior surface of the sponge only (**sand cortex**). There are several groups of sponges that are notorious in being able to organise foreign particles into a 'foreign skeleton', artially or completely replacing the 'native skeleton' (e.g. *Dysidea*, *Hyrtios*, *Phoriospongia*, *Psammoclema*, *Clathriopsamma*). These so-called **arenaceous sponges** are usually easily detected in the field by their harsh, sandy texture.

**3.2.9. Skeletal structure.** Structurally the sponge may be divided into two major skeletal regions:

3.2.9.1. The outer surface of the sponge (**ectosome, dermis** or **cortex**), bounded by single (epithelial) cells on the external surface. In some groups there may be a specialised skeleton on the surface (the **ectosomal skeleton**), composed of both or either spongin fibres and spicules.

3.2.9.2. The inner region of the sponge (**choanosome**) includes all organic portions of the sponge inside the epithelial cells (mesohyl, comparable to the mesenchyme of higher multicellular animals), including the water current system. Both spicules and spongin fibres may be present in the choanosome, although one or both may be lost in some groups. There are no true tissues, organs or coordinated nervous systems in the Porifera, although there are documented instances of limited locomotion and coordinated contractile responses. Traditionally the choanosomal region near the periphery is called the **subectosome**.

The patterns in which the organic and inorganic skeletons grow are informative at all levels of sponge taxonomy and generally useful in their identification. A special terminology has been produced to define this range of skeletal structures, with several categories of skeletal architecture recognised (although combinations and intermediate forms of these may also occur)

3.2.9.3. Branching and rejoining network (**reticulate**), producing regular triangular meshes (**isodictyal reticulate**) or quadrangular meshes (**myxillid reticulate**).

3.2.9.4. Repeatedly branching but not rejoining (**dendritic**).

3.2.9.5. Diverging, expanding, but not branching (**plumose**).

3.2.9.6. Diverging, simply concentric (**radial**).

3.2.9.7. Disorganised criss-crossed spicule (**halichondroid**).

**3.2.10. Spongin fibres.** In several orders of sponges the mineral skeleton has been lost completely, and for these groups fibre characteristics are important in their classification. In other groups, where there is both spongin fibres and spicules, the latter may be partially or fully contained inside the former, and thus the skeletal architecture is predominantly dictated by the form of the organic skeleton. In some groups (e.g. some Haplosclerida) there are no fibres but spicules are cemented together with granular collagen. Mostly, though, spongin fibres are useful in identification.

Spongin fibres vary both in a hierarchy of size and construction. Three size categories of fibres are generally recognised (primary, secondary, tertiary fibres), sometimes differentiated by both size, construction, and the material contained within each type of fibre. In addition to these fibres some groups have **collagen filaments** (e.g. *Ircinia*), which are minute, convoluted, terminally swollen collagenous structures dispersed within the mesohyl.

Several other classes of fibre construction are recognised, based on the amount of spongin protein deposited when the fibre was secreted, and whether or not this spongin was deposited evenly (homogenous fibres) or periodically (stratified fibres).

Sponges with heavy spongin fibres are often termed 'horny' or 'keratose' sponges. The most simple fibres are homogeneous in cross section without a central core (or visible **pith**) (e.g. *Spongia*), whereas the most 'complex' fibres are stratified in cross section, composed of concentric rings of protein (**bark**), with an optically diffuse pith in the centre of each fibre (e.g. *Aplysina*). Intermediate forms are also common, such as found in species of *Thorecta* with slightly stratified (**laminated**) fibres (not bark-like), with a granular pith.

3.2.11. **Mineral skeleton.** The inorganic or mineral skeleton is traditionally the most important feature for identifying sponges. This skeleton may consist of a fused, coral-like basal skeleton and/or individual components called **spicules**.

3.2.11.1. **Basal skeleton.** Some groups of sponges secrete a secondary, calcareous (**hypercalcified**), spicular basal skeleton, in addition to free siliceous or calcitic spicules. This feature was once considered diagnostic for a class of sponges known as 'sclerosponges', but is now interpreted as a grade of construction found within both Calcarea and Demospongiae. The species concerned (e.g. *Astrosclera*) usually live in coral reefs and their calcareous skeletons contribute to the overall accretion of these reefs.

3.2.11.2. **Spicules.** These are classified according to five major criteria:

3.2.11.2.1. Chemical composition. These may be silicate or calcitic, indicating division between the classes Demospongiae and Calcarea.

3.2.11.2.2. Spicule size. Larger spicules, called **megascleres**, contribute to the skeletal framework within the sponge, whereas smaller ones, **microscleres**, are packed between tracts of megascleres, supporting the soft parts. Spicule sizes are essential criteria in defining species, in some examples providing the only easy clues to distinguishing related species, whereas absolute spicule dimensions are less important at higher taxonomic levels.

3.2.11.2.3. Spicule fusion. Most spicules are free within the mesohyl or bound together by the organic skeleton, whereas some are characteristically fused together, producing an interlocking or articulated skeleton. In the Calcarea order Murrayonida these spicules consist of rigid monospicular skeletons composed of modified **triaxons**; in the Demospongiae order Lithistida these are special spicules called **desmas**.

3.2.11.2.4. Spicule distribution. Localisation of spicules to particular regions is a relatively common phenomenon. These include **ectosomal spicules** (or cortical spicules, found on the surface of the sponge), **principal spicules** (forming the major structural tracts, or found exclusively inside spongin fibres), **auxiliary spicules** (found outside the fibres, scattered within the mesohyl and/or just below the surface), and **echinating spicules** (or accessory spicules, poking through the fibres, perpendicular to them). Only few groups of sponges have all four categories of spicules.

3.2.11.2.5. Spicule shape or geometry. There is an extremely diverse range of shapes known for the phylum, and this is probably the single most important character in the current system of sponge taxonomy. Even in a single species there may be many sorts of spicules.

To assist in defining spicule shapes a specialised terminology has evolved.

#### **Megascleres:**

3.2.11.2.5.A. Number of central axes (**axons**): **monaxonic** spicules with no more than two rays (points of growth); **triaxonic** spicules with three perpendicular axes; **tetraxonic** spicules with four rays, each with a central axis.

3.2.11.2.5.B. Number of rays (**actines**): **monactinal** spicules have one ray with asymmetrical ends (i.e. the spicule is secreted by one or more cells commencing at one end and finishing at another); **diactinal** spicules have two rays, with symmetrical ends (i.e. the spicule is secreted in both directions by one or more cells, commencing at the centre); **tetractinal** spicules have more than two rays.

#### **Microscleres:**

3.2.11.2.5.C. **Meniscoid** or **sigmoid** microscleres include a diversity of curved, symmetrical and asymmetrical spicules (chela and sigmas).

3.2.11.2.5.D. **Monaxonic** microscleres include spicules with only a single axis and one or two rays.

3.2.11.2.5.E. **Asterose** microscleres are tetraxonic, with more than one axis and more than two rays.

3.2.12. **Cytology.** Several cytological characters have been instrumental in providing further understanding of the relationships within the Porifera, particularly at higher taxonomic levels. Foremost amongst these are choanocyte ultrastructure (including the presence, absence and position of the nucleus within the choanocyte), and the distribution of choanocytes and shape of choanocyte chambers (e.g. spherical, sac-like or elongate and branching). The characters have been particularly useful in describing relationships between the 'keratose' or aspicular sponges. Other cytological characters, such as the possession of particular cell types (e.g. cells with inclusions), have so far been found to be of limited value, possibly because they are still documented for only few species and still poorly understood.

3.2.13. **Larvae and reproductive strategy.** Larval morphology is known for only relatively few species, but in these cases it appears to be a consistent character useful for sponge taxonomy. Larval shape (e.g. solid parenchymella, hollow amphiblastula), pattern of ciliation (e.g. partial, complete) and mode of locomotion (e.g. swimming versus creeping) are all useful descriptive features. Mode of reproduction, including sexual and asexual modes, has been particularly useful in developing taxonomic hypotheses for sponges. Several reproductive characters been important in the detection of cryptic sibling species, such as whether larvae are brooded within the parent or gametes are broadcast into seawater, and the periodicity of spawning events. For example, sympatric populations of closely related species of *Xestospongia* were found to have markedly different reproductive strategies, possibly serving as a mechanism for niche separation (sympatric speciation). Some of these characters have also been used at higher levels of classification, particularly oviparity versus viviparity, although our knowledge of such strategies is still incomplete.

3.2.14. **Ecology.** Ecological data are virtually essential in modern sponge taxonomic descriptions, although sadly they are lacking from most of the earlier literature that described many the known species. These data are most useful at the species level, with proven success in being able to clearly differentiate living populations of closely related (morphologically similar) species when it is not always possible to do so from preserved specimens. However, it is still difficult, or impossible in some cases, to reconcile many of the older nineteenth century species descriptions with living populations, and clearly this is one of the major challenges facing sponge biologists for years to come.

#### 4. MAJOR CHARACTERS USED TO DESCRIBE DEMOSPONGIAE, BASED ON THE 'DELTA' (CSIRO COMPUTERISED DESCRIPTIONS) FORMAT.

□ Note: In applying objective criteria to sponge taxonomy we have tried to quantify perhaps the unquantifiable. Much of the process in current sponge taxonomy involves subjective interpretation of characters and their character states, such that there are rarely hard boundaries between one character state and the next one. The characters and states listed here are applicable mainly to demosponges, and they are certainly far from complete. Nevertheless, this list does provide a useful recipe to follow in describing a sponge.

\*SHOW Note that this character list is still in the developmental stage and may be frustrating to use

\*SHOW Sponge character list. Revised JNAH 28-NOV-1993

##### \*CHARACTER LIST

##### #1. <EXTERNAL MORPHOLOGY> <COMMUNITY> sponge/

1. macrobenthic, fixed to the substrate/
2. macrobenthic, fixed to rolling over substrate/
3. endolithic, burrowing into soft substrate/
4. excavating, bioeroding, boring into substrate/
5. encrusting, photophilic, exposed/
6. encrusting, sciaphilic, sheltered in overhangs or caves/
7. zoophytic, overgrowing live organic substrates/

##### #2. <EXTERNAL MORPHOLOGY> <GROWTH FORM>/

1. thinly encrusting/
2. thickly encrusting/
3. insinuating, boring calcitic substrates/
4. enlarged basal portion below substrate, fistules

- protruding through substrate/
5. lobate, spherical-bulbous/
6. lobate, massive/
7. lobate, stoloniferous, spreading over substrate/
8. simple whip-like (flagelliform), unbranched/
9. arborescent, simple branching, cylindrical digitate branches, few bifurcations/
10. arborescent, cylindrical digitate branches, complex branching, repeatedly bifurcate/
11. arborescent, flattened digitate branches, complex branching, repeatedly bifurcate/
12. arborescent, flattened digitate branches, complex reticulate branching in one plane/
13. arborescent, flattened digitate branches, complex reticulate branching in more than one plane/
14. arborescent, bushy, irregular branches, thickly branching in more than one plane/
15. arborescent, bushy, flattened branches, thickly branching in more than one plane/
16. tubulo-digitate, solid construction/

17. hollow, single tubular digit/
18. hollow, bifurcate tubular digits/
19. hollow, several tubular digits attached to common base/
20. lamellate, plate-like/
21. fan-shaped (flabelliform), with lamellae in one plane/
22. fan-shaped (flabelliform), with lamellae in more than one plane/
23. capitate/
24. club-shaped/
25. cup-shaped/
26. vase-shaped/
27. spherical (golf ball)/

#3. <EXTERNAL MORPHOLOGY> <POINT OF ATTACHMENT> attached/

1. directly to substrate/
2. directly to substrate, with enlarged basal holdfast/
3. to substrate with basal portion burrowed into sediment/
4. to substrate, insinuating into cavities/

#4. <EXTERNAL MORPHOLOGY> <HUE>/

1. /
1. pale/
2. light/
3. bright/
4. dark/
5. olive/
6. drab/
7. mottled/
8. deep/
9. speckled/
10. reddish/
11. greyish/
12. brownish/

#5. <EXTERNAL MORPHOLOGY> <LIVE COLOURATION>/

1. unknown/
2. white/
3. beige/
4. yellow/
5. blue/
6. turquoise/
7. green/
8. blue-green/
9. orange/
10. pink/
11. red/
12. red-orange/
13. red-brown/
14. maroon/
15. brown/
16. grey-brown/
17. grey/
18. black/

#6. <EXTERNAL MORPHOLOGY> <PRESERVED COLOUR> colour in ethanol/

1. white/
2. beige/
3. pale beige/
4. light yellow/

5. yellow/
6. brown/
7. dark brown/
8. grey-brown/
9. grey/
10. black/

#7. <EXTERNAL MORPHOLOGY> <OSCULE SHAPE>/

1. not visible/
2. conspicuous, discrete, with a slightly raised membranous lip/
3. conspicuous, discrete with a slightly raised membranous lip, and subectosomal drainage canals radiating away from oscules forming stellate grooves on surface/
4. large, terminal, raised, on apex of small surface papillae/
5. large, terminal, raised, on the apex of fistules/
6. small, evenly scattered over the surface, producing porous-reticulate appearance/

#8. <EXTERNAL MORPHOLOGY> <OSCULE DISTRIBUTION>/

1. /
2. on apex of sponge, confined to distinct pore areas (sieve-plates)/
3. on apex of sponge, confined to distinct pore areas (porocalyces)/
4. on apex of sponge, confined to distinct pore area (capitum)/
5. mainly on lateral sides of branches/
6. mainly on external surface of lamellae/
7. mainly on apex of digits/
8. scattered evenly over surface/

#9. <EXTERNAL MORPHOLOGY> <OSTIA> inhalant pores/

1. not visible/
2. minute, dispersed evenly over entire surface/
3. minute, dispersed over external surfaces/
5. minute, dispersed over internal surfaces/
6. minute, dispersed over lateral surfaces/

#10. <EXTERNAL MORPHOLOGY> <TEXTURE>/

1. unknown/
2. soft, slimy/
3. soft, mucousy/
4. firm, mucousy/
5. insubstantial, collapses out of water/
6. soft, spongy, compressible/
7. firm, rubbery/
8. tough, compressible, difficult to tear/
9. brittle, easily crumbled/
10. firm, barely compressible/
11. firm, incompressible/
12. stony/

#11. <EXTERNAL MORPHOLOGY> <SURFACE>/

1. translucent, membranous/
2. translucent, membranous, optically smooth/
3. translucent, membranous, hispid/

4. opaque/
5. opaque, membranous, optically smooth/
6. opaque, membranous, hispid/
7. opaque, slightly collagenous, lightly pigmented/
8. arenaceous, with crust of detritus/
9. fleshy, collagenous, heavily pigmented/
10. dense, spiculose, heavily pigmented/

#12. <EXTERNAL MORPHOLOGY> <SURFACE SCULPTURING>/

1. even, unornamented/
2. even, choanosomal fibres clearly visible below surface/
3. even, spicules perpendicular to surface/
4. even, spicules tangential to surface forming cobweb-like network/
5. even, with detachable crust of spicules, paratangential or tangential to surface/
6. uneven, subectosomal drainage canals, grooves or ridges clearly visible below surface/
7. uneven, conulose, prominently sculptured, with tangential spicule skeleton forming cobweb-like network running between surface conules/
8. uneven, with regularly dispersed microconules/
9. uneven, clathrous, with bifurcated surface processes/
10. uneven, shaggy, with protruding fibres scattered over surface/
11. uneven, digitiform, with large widely spaced tapering surface processes/
12. uneven, papillose, with close-set, long, tapering surface processes/
13. uneven, with paratangential reticulated ectosomal fibres/

#13. <SKELETON> <ECTOSOMAL SKELETON>/

1. membranous, without spicule skeleton/
2. membranous, heavily collagenous/
3. membranous, arenaceous, with thick crust of sand grains and foreign spicule fragments lying on surface/
4. membranous, arenaceous, with sand grains and foreign spicule fragments incorporated into peripheral fibres/
5. membranous, with special ectosomal fibres tangential to surface/
6. membranous, with peripheral choanosomal fibres lying close to, and tangential to, surface/
7. membranous, hispid, with erect spicules from choanosomal skeleton protruding through surface/
8. unispicular, isotropic, single spicules lying tangential to surface/
9. unispicular, isodictyal, with single spicules lying tangential to surface/
10. uni- or paucispicular, isodictyal tracts of spicules lying tangential to surface/
11. uni- or paucispicular, radial tracts of spicules perpendicular to surface/

12. paucispicular, with sparse bundles of spicules paratangential or perpendicular to surface/
13. pauci- or multispicular, with discrete bundles of spicules standing perpendicular spicules/
14. multispicular, with a continuous palisade of spicules perpendicular to surface/
15. multispicular, with a thick crust with spicules tangential or paratangential to surface/
16. membranous, but with a felt of microscleres/

#14. <SKELETON> <ECTOSOMAL SPECIALISATION>/

1. /
2. composed of undifferentiated choanosomal spicules/
3. composed of undifferentiated subectosomal spicules/
4. composed of special category of ectosomal spicules scattered individually on surface/
5. composed of special category of ectosomal spicules forming erect bundles on surface/
6. composed of special category of ectosomal spicules forming continuous palisade on surface/
7. composed of dense crust of subectosomal spicules, tangential or paratangential to surface/
8. composed of acanthostyles in plumose brushes around protruding subectosomal spicules/
9. raspailiid, with bundles of ectosomal auxiliary spicules surrounding larger protruding subectosomal spicules/
10. raspailiid, with plumose bundles of choanosomal spicules surrounding larger protruding spicules/
11. composed of bundles of raphides dispersed over ectosome and surrounding larger protruding spicules/

#15. <SKELETON> <SUBECTOSOMAL SKELETON>/

1. /
2. undifferentiated from choanosomal skeleton/
3. collagenous, lacking any region skeleton/
4. compressed, with fibres forming a more close-meshed reticulation in periphery than in axial skeleton/
5. cavernous, with peripheral fibres less compressed than in axial skeleton/
6. vestigial, with spicules sparsely dispersed throughout peripheral skeleton/
7. compressed, with more-or-less disorganized tangential tracts of spicules lying below ectosome/
8. compressed, with more-or-less disorganized paratangential tracts of spicules lying below ectosome/
9. scattered tangential tracts of spicules lying below ectosome/
10. single or paucispicular isodictyal tracts/
11. cavernous, with wide-meshed reticulate tracts of

spicules lying below ectosome/

12. plumo-reticulate, with diverging and anastomosing

tracts of spicules supporting ectosome/

13. plumose, with diverging brushes of spicules supporting ectosome/

14. radial, with perpendicular bundles of spicules supporting ectosome/

15. radial, with single spicules perpendicular to axis

protruding through ectosome/

#16. <SKELETON> <SUBECTOSOMAL SPECIALISATION>/

1. /

2. composed of undifferentiated choanosomal spicules/

3. composed of undifferentiated ectosomal spicules/

4. composed of special category of auxiliary spicules, geometrically different from choanosomal spicules/

5. composed of special category of auxiliary spicules, differing from ectosomal spicules only in dimensions/

6. composed of special category of auxiliary spicules, differing from choanosomal spicules only in dimensions/

7. composed of echinating spicules concentrated in peripheral skeleton/

8. supplemented by sand grains and other foreign particles dispersed throughout peripheral skeleton/

#17. <SKELETON> <CHOANOSOMAL ARCHITECTURE>/

1. collagenous/

2. hymedesmoid/

3. microcionid/

4. plumose/

5. plumo-reticulate/

6. irregularly reticulate/

7. regularly reticulate/

8. renieroid-subisodictyal reticulate/

9. isodictyal reticulate/

10. isotropic reticulate/

11. disorganised halichondroid reticulate/

#18. <SKELETON> <CHOANOSOMAL AXIAL AND EXTRA-AXIAL DIFFERENTIATION> with/

1. /

2. undifferentiated axial or extra-axial regions/

3. wide-meshed relatively homogeneous fibres/

4. wide-meshed skeletal tracts/

4. compressed basal fibres, and radial extra-axial skeleton/

5. compressed basal fibres and plumose extra-axial skeleton/

6. compressed basal skeleton composed of short bulbous

fibre nodes, cored by plumose tufts of radiating extra-

axial spicules/

7. differentiated, compressed, reticulate axis, and plumo-reticulate extra-axis/

8. differentiated, compressed, reticulate axis, and plumose extra-axis/

9. differentiated, compressed, reticulate axis, and radial extra-axis/

10. differentiated plumose axis, and radial extra-axis/

11. mostly non-anastomosing fibres and spicule tracts/

12. differentiated primary (plumose-dendritic) and secondary (renieroid-subrenieroid) skeletons/

13. differentiated primary multispicular skeleton and

secondary renieroid skeleton/

14. radially dispersed single spicules or paucispicular

tracts of spicules throughout/

15. a criss-cross of spicules, vaguely recognisable in

structure only at the periphery/

16. -out apparent skeletal organization/

#19. <SKELETON> <CHOANOSOMAL SKELETAL TRACTS>/

1. /

2. basal fibres aspiculose, although bases of spicules embedded in spongin fibres, standing perpendicular to

substrate/

3. homogeneous unispicular skeletal tracts cored by choanosomal spicules/

4. homogeneous uni- or paucispicular skeletal tracts

cored by choanosomal spicules/

5. homogeneous multispicular skeletal tracts cored by

choanosomal spicules, occupying only proportion of fibre

diameter/

6. homogeneous multispicular skeletal tracts cored by

choanosomal spicules, occupying entire fibre diameter/

7. homogeneous multispicular skeletal tracts cored by

auxiliary spicules identical to those in peripheral skeleton/

8. homogeneous multispicular skeletal tracts cored by

choanosomal spicules with echinating spicules secondarily incorporated into fibres/

9. larger primary (ascending) and smaller secondary

(transverse) skeletal tracts cored by principal spicules/

10. larger primary (ascending) skeletal tracts cored by

principal spicules, smaller secondary (connecting) tracts cored by auxiliary spicules/

11. larger primary (ascending) skeletal tracts cored by

principal spicules, smaller secondary (connecting) tracts aspiculose/

12. larger primary (ascending) skeletal tracts cored by

auxiliary spicules, smaller secondary (connecting) tracts aspiculose/

13. only primary (ascending) skeletal tracts present,

cored by principal spicules, without connecting tracts/

14. skeletal tracts in axial skeleton cored by auxiliary spicules, whereas tracts in peripheral region

wholly arenaceous/

15. primary spongin fibres interconnected by smaller

secondary fibres/

16. without spongin fibres or spicule tracts, although

collagen fibrils present/

#20. <SKELETON> <CHOANOSOMAL SPICULES> choanosomal

spicules/

1. /

2. absent/

3. completely enclosed in spongin fibres/

4. core spongin fibres as well as echinate fibre endings, protruding through fibres in "spicate" arrangement/

5. echinates spongin fibres as well as form plumose

ascending brushes in peripheral skeleton/

6. echinate fibre nodes/

7. strewn in loosely aggregated tracts within mesohyl/

8. strewn in halichondroid tracts within mesohyl/

9. form secondary renieroid skeleton, without a fibre

component, bound at nodes by collagen/

10. form a rigid, interlocking skeleton/

#21. <SKELETON> <CHOANOSOMAL ECHINATING SPICULES>

echinating spicules/

1. /

2. absent (presumed lost)/

3. absent, although second category of larger, acanthose choanosomal spicule present/

4. absent, although cladotylotes echinate skeletal tracts/

5. clumped on basal spongin/

6. concentrated in tufts at fibre nodes/

7. concentrated on exterior edges of skeletal tracts/

8. concentrated on primary skeletal tracts/

9. confined to peripheral skeleton, forming plumose

brushes on ectosome, surrounding protruding subectosomal

spicules/

10. clumped at junction of axial and extra-axial skeletons, around bases of subectosomal spicules/

11. secondarily incorporated into fibres/

12. form a dense, rigid, interlocking secondary skeleton/

13. forming plumose or subrenieroid tracts only/

14. sparse, evenly distributed over skeletal tracts/

15. heavy, evenly distributed over skeletal tracts/

16. supplemented by cladotylotes also echinating skeletal tracts/

#22. <SKELETON> <CHOANOSOMAL SPONGIN FIBRES> spongin

fibres/

1. /

2. absent/

3. absent, spicule tracts bound together at their

nodes by collagen/

4. poorly developed/

5. poorly developed, lightly invested with spongin, homogeneous in cross-section/

6. poorly developed, lightly invested with spongin, spicule tracts mostly bound together by granular collagen/

7. poorly developed, replaced mostly by algal filaments/

8. well developed, with optically diffuse central pith/

9. well developed, supplemented by spongin spicules/

10. well developed, supplemented by collagen filaments/

11. well developed, supplemented by a mesentary-like

tertiary "fibre" network/

12. well developed, fibres strongly and concentrically

lamellated and stratified, with both bark and pith elements/

13. reduced to a layer of spongin lying on substrate,

without coring spicules/

#23. <SKELETON> <INCORPORATED DETRITUS>

1. /

2. with sand grains incorporated into fibres/

3. with sand grains and foreign spicule fragments incorporated into fibres/

4. fully cored by detritus, obscuring most spicule tracts/

#24. <SKELETON> <CHOANOSOMAL MESOHYL> collagen/

1. seen mainly around spicule tracts and spicule nodes/

2. abundant, lightly pigmented, dispersed evenly throughout mesohyl/

3. abundant, darkly pigmented, dispersed evenly throughout mesohyl/

4. abundant, granular, with pigment bodies clumped

within mesohyl, darkly pigmented/

5. abundant, with abundant collagenous filaments/

#25. <SKELETON> <CHOANOCYTE CHAMBERS> choanocyte

chambers/

1. /

2. small, oval <40-200 micrometres diameter>/

3. small, oval-elliptical <20-200 micrometres diameter>/

4. large, oval-elongate <200-300 micrometres diameter>/

5. minute, ovoid <5-40 micrometres diameter>/

6. paired <50-350 micrometres diameter>/

#26. <SPICULES> <MEGASCLERES, PRINCIPALS, NO.CATEGORIES>/

1. /

2. principal spicules absent/

3. single category of principal spicule/

4. two categories of principal spicules/

5. three categories of principal spicules/

#27. <SPICULES> <MEGASCLERES,  
MONACTINAL, PRINCIPALS>  
choanosomal principal spicules are/  
1. /  
2. styles/  
3. subtylostyles/  
4. tylostyles/  
5. acanthostyles/  
6. rhabdostyles/  
7. quasi-diactinal spicules (asymmetrical)/  
8. strongyles/  
9. acanthostrongyles/  
10. sinuous strongyles/  
11. tylotes <amphitylotes>/  
12. tornotes/  
13. oxeas/  
14. anisoxeas/  
15. strongyloxeas/  
16. tuberculate vermiform strongyles/  
17. cladotyloles/

#28. <SPICULES> <MEGASCLERES,  
MONACTINAL, PRINCIPALS>/  
1. /  
2. entirely smooth/  
3. with lightly acanthose base and smooth shaft/  
4. with heavily acanthose base and smooth shaft/  
5. with acanthose base, partly acanthose neck, but  
remainder of shaft smooth/  
6. acanthose at both base and apex, with smooth  
shaft/  
7. acanthose only at extremities/  
8. entirely acanthose/  
9. with spines in verticillate rows/

#29. <SPICULES> <MEGASCLERES,  
MONACTINAL, PRINCIPALS>  
with/  
1. /  
2. evenly rounded bases, fusiform points/  
3. evenly rounded bases, hastate points/  
4. subtylote bases, fusiform points/  
5. subtylote bases, hastate points/  
6. tylote bases, fusiform points/  
7. tylote bases, hastate points/  
8. tapering fusiform bases, fusiform points/  
9. tapering fusiform bases, hastate points/  
10. tapering pointed bases, fusiform points/  
11. tapering pointed bases, hastate points/  
12. rounded and mucronate bases, fusiform points/  
13. rounded and mucronate bases, hastate points/  
14. tuberculate bases, fusiform points/  
15. tuberculate bases, hastate points/  
16. slightly rhabdose bases, fusiform points/  
17. slightly rhabdose bases, hastate points/  
18. rhabdose bases, fusiform points/  
19. rhabdose bases, hastate points/  
20. rhabdose bases with a spiral twist, fusiform  
points/  
21. rhabdose bases with a spiral twist, hastate  
points/  
22. fusiform points/  
23. hastate points/  
24. tapering rounded points/  
25. evenly rounded points/  
26. hastate, telescoped points/  
27. sinuous, flexuous points/

#30. <SPICULES> <MEGASCLERES,  
TETRACTINAL, PRICIPALS>/  
1. /  
2. short-shaft mesotriaenes/  
3. plagiotriaenes/  
4. anatriaenes/  
5. protriaenes/  
6. promonaenes/  
7. orthotriaenes/  
8. dichotriaenes/  
9. trichotriaenes/  
10. trichodal or heterocladal protriaenes/  
11. discotriaenes/  
12. phyllotriaenes/  
13. oxytylotes (diacts)/  
14. absent (presumed secondary loss)/  
15. discrete spicules absent, skeleton entirely fused  
calcitic or aragonitic basal skeleton  
(hypercalcified)/

#31. <SPICULES> <MEGASCLERES,  
TETRACTINAL, DESMAS FORMING  
SECONDARY CHOANOSOMAL SKELETON>/  
1. /  
2. ophirhabds (monocrepidial)/  
3. dendroclones (monocrepidial)/  
4. tricanoclones (tricrepidial)/  
5. rhizoclones (monocrepidial)/  
6. fused heloclones (monocrepidial)/  
7. megaclones (monocrepidial)/  
8. tetraclones (tetracrepidial)/  
9. rhabdorepids (monocrepidial)/  
10. sphaeroclones (tetracrepidial)/

#32. <SPICULES> <MEGASCLERES,  
AUXILIARY, NO.CATEGORIES>/  
1. /  
2. auxiliary spicules absent/  
3. single category of auxiliary spicule/  
4. two categories of auxiliary spicules in ectosomal  
and subectosomal regions, respectively/  
5. three categories of auxiliary spicules, with  
different distributions in ectosomal and  
subectosomal  
regions/

#33. <SPICULES> <MEGASCLERES,  
AUXILIARY  
> auxiliary  
spicules are/  
1. /  
2. styles/  
3. subtylostyles/  
4. tylostyles/  
5. acanthostyles/  
6. rhabdostyles/  
7. quasi-diactinal spicules (asymmetrical)/  
8. strongyles/  
9. acanthostrongyles/  
10. sinuous strongyles/  
11. tylotes <amphitylotes>/  
12. tornotes/  
13. oxeas/  
14. anisoxeas/  
15. strongyloxeas/  
16. tuberculate vermiform strongyles/  
17. cladotyloles/  
18. polyactinal (asterose)/



#34. <SPICULES> <MEGASCLERES,  
SUBECTOSOMAL AUXILIARY>

- with/  
1. /  
2. entirely smooth base and shaft/  
3. lightly microspined bases/  
4. heavily microspined bases/  
5. with microspined bases and points, smooth shaft/  
6. entirely spined/

#35. <SPICULES> <MEGASCLERES,  
SUBECTOSOMAL AUXILIARY>  
and/

1. /  
2. evenly rounded bases, fusiform points/  
3. evenly rounded bases, hastate points/  
4. subtylote bases, fusiform points/  
5. subtylote bases, hastate points/  
6. tylote bases, fusiform points/  
7. tylote bases, hastate points/  
8. tapering rounded base, fusiform points/  
9. tapering rounded base, hastate points/  
10. fusiform points/  
11. hastate points/  
12. tapering rounded points/  
13. evenly rounded points/  
14. hastate, telescoped points/  
15. sinuous, flexuous points/

#36. <SPICULES> <MEGASCLERES,  
CALTHROPS AUXILIARY  
SPICULES>/

1. /  
2. absent (presumed secondary loss)/  
3. undifferentiated calthrops/  
4. tetrapod calthrops/  
5. centrangulate diacts/  
6. monolophs (lophotetractines)/  
7. candelabra/  
8. amphimesodichotriaenes/  
9. short-shafted dichotriaenes/

#37. <SPICULES> <MEGASCLERES,  
ECHINATING, NO.CATEGORIES>/

1. /  
2. echinating spicules absent/  
3. identical in size and geometry to principal spicules/  
4. single category of echinating spicule/  
5. two categories of echinating spicules/  
6. three categories of echinating spicules/

#38. <SPICULES> <MEGASCLERES,  
ECHINATING, CURVATURE>  
echinating spicules/

1. /  
2. straight/  
3. slightly curved at centre/  
4. greatly curved at centre/  
5. slightly curved in distal third of shaft/  
6. slightly curved in basal third of shaft/

#39. <SPICULES> <MEGASCLERES,  
ECHINATING, SHAPE>/

1. /  
2. club-shaped/  
3. cylindrical, rod-like/  
4. subcylindrical, sausage-shaped/

5. triactinal <three rays>/  
6. tetractinal <four rays>/  
7. polyactinal <many rays>/  
8. di-, tri- and tetractinal/

#40. <SPICULES> <MEGASCLERES,  
ECHINATING, GEOMETRY>/

1. /  
2. acanthostyles, rounded bases, fusiform points/  
3. acanthostyles, rounded bases, hastate points/  
4. acanthostyles, subtylote bases, fusiform points/  
5. acanthostyles, subtylote bases, hastate points/  
6. acanthostyles, prominently tylote bases, fusiform points/  
7. acanthostyles, prominently tylote bases, hastate points/  
8. smooth styles, rounded bases, fusiform points/  
9. smooth styles, rounded bases, hastate points/  
10. smooth styles, subtylote bases, fusiform points/  
11. smooth styles, subtylote bases, hastate points/  
12. smooth strongyles, evenly rounded bases/  
13. acanthostrongyles/  
14. smooth rhabdostyles/  
15. acanthorhabdostyles/  
16. sagittal triacts (acanthoplagentriaenes), including tetracts and quasi-diaacts/  
17. cladotyloles with smooth shaft/  
18. cladotyloles with spined shaft/  
19. choanosomal rhabdostyles, identical in geometry to principal spicules/  
20. diactinal acanthorhabds/  
21. robust, fusiform oxeas/  
22. acanthoxeas/

#41. <SPICULES> <MEGASCLERES,  
ECHINATING, SPINATION>/

1. /  
2. entirely smooth/  
3. entirely acanthose, with small granular spines dispersed evenly/  
4. entirely acanthose, well large spines dispersed evenly/  
5. with small spines on base only/  
6. with heavy spines on base only/  
7. with spines on base and "neck" only/  
8. with smooth base and spines on point and shaft only/  
9. with spines on base and shaft but smooth point/  
10. with spines evenly dispersed over spicule except for aspinose "neck"/  
11. with smooth shaft and spines only on extremities/  
12. with large recurved clads on apex, swollen base, smooth shaft/  
13. with large strongly recurved clads on both ends, smooth shaft/  
14. with large strongly recurved clads on apex, small clads on base, lightly spined shaft/  
15. with small clads on both base and apex, and lightly spined shaft/

16. with small clads on both base and apex, and smooth shaft/

17. with large erect spines covering, and nearly perpendicular to, shaft/

18. with small scattered spines over shaft, and clads

(large, strongly recurved hooks) present on both base

and apex of spicule/

19. with spines on major axis (longest arm) only/

20. with spines on all axes/

21. with spines in regular, verticillate rows, covering

most of spicule/

#42. <SPICULES> <MICROSCLERES, NO.CATEGORIES>/

1. single category microsclere/

2. two categories microscleres/

3. three categories microscleres/

4. four categories microscleres/

5. five categories microscleres/

6. six categories microscleres/

7. seven categories microscleres/

8. eight categories microscleres/

9. nine categories microscleres/

10. absent/

11. /

#43. <SPICULES> <MICROSCLERES, MENISCOID, GEOMETRY>

consisting of/

1. /

2. unmodified palmate isochelae/

3. palmate isochelae, including contort forms/

4. cleistochelae/

5. arcuate isochelae/

6. anchorate isochelae/

7. bidentate sigmoid isochelae/

8. unguiferous isochelae/

9. Isodictya-like isochelae/

10. crocae (J-shaped) chelae/

11. birotulates/

12. bipocillae/

13. palmate anisochelae/

14. placocheleae/

15. sphaerancora/

16. canonocheleae/

17. clavidiscs (compound diancistras <Merlia>/

18. diancistras, sigmoid, with central and apical notches/

19. cyrtancistras, with serrated inner margin

<sigmoid>/

20. sigmancistras, with vestigial central notch/

21. c-sigmas/

22. s-sigmas/

23. spirosigmas, small, contort, rugose/

24. thraustosigmas, large, irregular, crooked, rugose/

25. centrangulate sigmas/

26. tetrapocillae/

27. spined isancorae/

28. spined isochelae/

#44. <SPICULES> <MICROSCLERES, TOXAS, GEOMETRY>/

1. /

2. oxborn toxas, completely, smooth, reflexed arms,

wide central curvature/

3. oxborn toxas, reflexed arms with spines on points,

wide central curvature/

4. accolada toxas, slight central curvature, long straight arms, straight points, /

5. thin, deeply curved toxas, straight points/

6. v-shaped toxas, sharp angular central curvature, straight arms, straight points/

7. v-shaped toxas, sharp angular central curvature, straight arms, slightly reflexed points/

8. asymmetrical, sinuous toxas/

9. oxeote toxas, no or vestigial curvature, straight points/

10. acanthose cladotoxas/

11. smooth forceps/

12. acanthose forceps/

#45. <SPICULES> <MICROSCLERES, OTHER MONAXONIC, GEOMETRY>/

1. /

2. discorhabds <Didiscus>/

3. anthosigmas/

4. sanidastoid discorhabds/

5. anisodiscrohabds/

6. spirasters/

7. spinispiras/

8. spirulas/

9. toxaspires/

10. sigmaspires/

11. selenasters/

12. smooth microxeas/

13. acanthose microxeas/

14. microstrongyles/

15. oval microstrongyles/

16. centrotylote microxeas/

17. smooth microstyles/

18. rugose microstyles/

19. microtylostyles/

20. "microrhabds", degenerate microxeas/

21. smooth commata/

22. rugose commata/

23. spheres/

24. raphides/

25. trichites, bundles of raphides/

26. onychaetes/

27. spined centrotylote rods/

28. spear-shaped microstyles/

29. thraustoxeas/

30. sanidasters/

31. "ecailles", monorepidial disc/

#46. <SPICULES> <MICROSCLERES, ASTROSE>/

1. /

2. plesiaster streptasters/

3. amphiaser streptasters/

4. metastar streptasters/

5. spiraster streptasters/

6. oxyaster euasters/

7. oxyspheraster euasters/

8. pycnaster euasters/

9. strongylaster euasters/

10. tylaster euasters/

11. anthaster euasters/

12. anthospheraster euasters/

- |  |   |
|--|---|
| 13. sterrospheraster euaster/<br>14. sterraster euasters/<br>15. aspidaster euasters/<br>16. ataxasters euasters (acanthosphaera, or degenerate euasters)/ | #49. <SPICULES> <DIMENSIONS CALTHROPS AUXILIARY MEGASCLERES>/<br>#50. <SPICULES> <MEGASCLERES, ECHINATING, DIMENSIONS>/ |
| #47. <SPICULES> <DIMENSIONS PRINCIPAL MEGASCLERES>/  | #51. <SPICULES> <DIMENSIONS MICROSCLERES>/  |
| #48. <SPICULES> <DIMENSIONS AUXILIARY MEGASCLERES>/  | #52. <REMARKS>/   |

**5. KEY TO THE EXTANT ORDERS OF PORIFERA.**

**CLASS DEMOSPONGIAE**

- (1) Skeleton absent ..... 2
- Skeleton present ..... 7
- (2) Firm sponges with cartilaginous consistency ..... 3
- Soft sponges ..... 4
- (3) With leuconoid aquiferous system and diplodal choanocyte chambers; ectosome thick ... **Homosclerophorida** (*Pseudocorticium*)  
With a well developed cortex made of thick fascicles of fibrillar collagen, numerous spherulous cells, and inhalant apertures localised in special structures ..... **Chondrosida** (*Chondrosia*)
- (4) With fibrillar collagen only ..... 5
- With a nodular spongin fibre skeleton ..... **Chondrosida** (*Thymosia*)
- (5) Choanocyte chamber eurypylous, simple ..... 6
- Choanocyte chambers tubular and branched, size about 100um; ectosomal and subectosomal collagen highly organised and structurally diversified ..... **Halisarcida**
- (6) Ectosome thin, with sylleibid-like aquiferous system; choanocyte chambers eurypylous, rounded, less than 60um diameter ..... **Homosclerophorida** (*Oscarella*)  
With a thin cortex enriched with fibrillar collagen parallel to the surface, a superficial cuticle and pore-sieves may be present **Chondrosida** (*Thymosiopsis*)  
Ectosome strongly collagen-reinforced and bounded by a distinct skin, with spherulous cells ~10um in diameter are common throughout the mesohyl but particularly concentrated in the ectosome; sponge attaining a thickness of only about 5 mm; choanocyte chambers large and sac-shaped ..... **Verongida** (*Hexadella*)
- (7) Megascleres present ..... 8
- Only asterose microscleres present ..... **Chondrosida** (*Chondrilla*)
- Siliceous spicules absent (or secondarily lost) ..... 17
- (8) Spicules exclusively verticillate-spined styles or oxeas ..... **Agelasida**  
Spicules may be spined or smooth but are not exclusively verticillate- spined ..... 9
- Megascleres always include articulated siliceous desmas, with or without free spicules **Demospongiae 'lithistids'** (polyphyletic)
- (9) Megascleres are all monaxones ..... 10
- Megascleres include diods and/or triods, megascleres and microscleres undifferentiated, sometimes spicules are lost completely and sponge may be superficially confused with compound ascidians ..... **Homosclerophorida**
- Megascleres include triaenes ..... 16
- (10) Megascleres exclusively diactines (oxeas and/or strongyles) ..... 11
- Megascleres diverse or exclusively monactinal (tylostyles, styles, strongyloxeas) ..... 15
- (11) Asterose microscleres ..... **Astrophorida**
- No asterose microscleres ..... 12
- (12) Megascleres arranged in an isodictyal or anisodictyal reticulation ..... 13
- Megascleres arranged in a confused manner or plumose or plumo-reticulate ..... 14
- (13) Microscleres include chelae, megascleres often localized to distinct regions (e.g., inside fibres), sand/detritus may replace megascleres completely ..... **Poecilosclerida**  
No chelae; microscleres absent or restricted to sigmas, toxas, raphides, amphidiscs or microspined oxeas, megascleres diactinal usually producing well-formed structures such as triangular, rectangular or polygonal meshes ..... **Haplosclerida**
- (14) Microscleres include chelae and or sigmas or toxas ..... **Poecilosclerida**  
No chelae, sigmas or toxas ..... **Halichondrida**
- (15) Microscleres may be absent or may include asterose and monaxonic forms (microxeas, spirasters); skeleton peripherally radiate forming palisades of spicules at the surface ..... **Hadromerida**  
Microscleres include chelae and/or sigmas, occasionally microscleres are absent ..... **Poecilosclerida**

No asters, and no other microscleres other than trichodragmas (or raphides); skeleton peripherally tangential or undifferentiated, main skeleton composed of a criss-cross of spicules, or compressed into a distinct axis, or with plumose, plumo-reticulate or dendritic mineral skeleton, fibre system poorly developed or absent **Halichondrida**  
 (16) Microscleres sigmaspires (rugose c- or s-shaped), spherical growth form usual, radial pattern of triaenes and oxeas ..... **Spirophorida**  
 Microscleres rugose sigmaspires, no oxeas, no radial skeleton, no spherical growth form **Spirophorida** (Samidae)  
 Microscleres asters or streptoscleres, large oxeas always present, sometimes with triaenes, skeleton only obviously radial at the surface ..... **Astrophorida**  
 (17) Solid carbonate skeleton, lacking free spicules, with a solid cortex producing a series of chambers on top of each other, the youngest (uppermost) chambers lined with living tissue ..... **Verticillitida**  
 Skeleton of discrete spongin fibres ..... 8  
 (18) Fibres generally well laminated, containing a cellular mass visible as a dark pith in transmitted light, without differentiation of primary or secondary elements, many taxa aerophobic (darken in contact with air) .. **Verongida**  
 Fibres contain a core of sand or spicule fragments or are entirely free of inclusions ..... 19  
 (19) Skeleton an anastomosing system of interconnected fibres, often well developed and relatively homogeneous fibre construction with 2–3 different sized networks, consistency not collagenous ..... **Dictyoceratida**  
 Skeleton consists of dendritic fibres arising from basal attachment, with fibres strongly laminated **Dendroceratida**  
 Skeleton with reticulate, plumoreticulate or plumose fibres containing sand or spicule fragments, with vestigial spicules (check for microscleres or echinating spicules) or occasionally no spicules at all ..... **Poecilosclerida**  
 Fibre skeleton well-developed, more-or-less regularly reticulate, and also with a tangential ectosomal (tertiary) network of fine aspicular fibres and foreign material, whereas choanosomal fibres are aspicular and with only foreign material (or sometimes extremely vestigial oxeas) ..... **Haplosclerida** (*Dactylia*)

#### CLASS HEXACTINELLIDA

(1) Amphidisc microscleres present; hexaster microscleres absent ..... **Amphidiscosida**  
 Astral (hexasters) microscleres present; amphidisc microscleres rare ..... 2  
 (2) Dictyonal framework formed of hexactins fused by secondary silicification ..... 3  
 Dictyonal framework of fused hexactins absent; fusion of non-hexactine megascleres (diactins, triactins, tetractins) may occur in older parts ..... **Lyssacosida**  
 (3) Dictyonal nodes mainly lychniscid, but some may be simple ..... **Lychniscosida**  
 Dictyonal nodes simple ..... 4  
 (4) Dictyonal meshes consistent in size and shape; dictyonal rays one mesh in length; dictyonal strands as serially aligned beam pairs ..... **Hexactinosida**  
 Dictyonal rays irregular in size and shape; dictyonal rays exceed mesh length; dictyonal strands as long single rays or multiple (>2) overlapping rays ..... **Aulocalycoida**

#### CLASS CALCAREA

(1) Regular (equiangular and equiradiate) triactines and tetractines, choanocytes basinucleate with spherical nuclei ..... (Calcinea) 2  
 Sagittal triactines & tetractines, choanocytes apinucleate ..... (Calcaronea) 3  
 (2) Skeleton composed exclusively of free spicules ..... **Clathrinida**  
 Reinforcement of the skeleton composed of either spicule tracts, calcareous plates or a rigid nonspicular skeleton. Diapasons or modified diactines present and generally fasciculated ..... **Murrayonida**  
 (3) Skeleton composed exclusively of free spicules ..... 4  
 Reinforcement of the skeleton consisting either of linked or cemented basal actines of tetractines, or of a rigid basal mass of calcite. Diapason spicules generally present. Aquiferous system leuconoid ..... **Lithonida**  
 (4) Skeleton either composed exclusively of microdiactines or in which microdiactines constitute exclusively or predominantly a specific sector of the skeleton. Large or giant spicules frequently present in the cortical skeleton. Dagger-shaped small tetractines (pugioles) frequently the sole skeleton of the exhalant aquiferous system. Aquiferous system leuconoid ..... **Baerida**  
 Free spicules diactines, sagittal triactines/tetractines. Aquiferous system asconoid, syconoid, sylleibid or leuconoid ..... **Leucosolenida**

### 7. PREFERRED FORMAT FOR SPONGE SAMPLES SENT FOR IDENTIFICATION

#### ☐ 7.1. Specimen data.

*In situ* colour photograph/slide (preferably of live specimen).

Field notes on colouration, overall shape, surface characteristics, mucus exudates, and any peculiar habits (e.g. burrowing, encrusting other fauna, etc.).

#### ☐ 7.2. Locality data.

Precise locality, including latitude and longitude (preferable decimal degrees and minutes, GPS accuracy).

Depth of collection.  
Date of collection.  
Collectors name(s).  
Mode of collection (SCUBA, dredge, etc.).  
Type of habitat (e.g. coral reef, mud fauna, mangrove, rocky shore, etc.).

❑ **7.3. Fixation and preservation.**

We prefer to receive specimens frozen if at all possible (and posted via courier, packed in dry ice), given that subsequent genetic studies can then be undertaken on these species. However, outside Australia this is difficult and expensive, in which case the following techniques should be used.

Ideally sponges should be frozen (to fix soluble pigments), and subsequently transferred to 70-80% ethanol. Do not use formaldehyde. Specimens should be kept in separate plastic bags, each with a label stating as a minimum a unique field/registration number.

Live specimens may alternatively be placed directly in 80-90% ethanol (they dilute themselves to about 70-80%); but beware, soluble pigments from darker species may leach into and discolour lighter coloured species if placed in the same container.

Specimens should be fixed and preserved for at least 48 hours prior to postage. Excess alcohol should be drained off; delicate specimens should be wrapped in cheese-cloth if damage is possible; and specimens heat-sealed in several layers of plastic bag.

❑ **7.4. Postage.**

Preserved specimens posted from overseas should contain the following statement, both on the exterior of the package and a copy inside the package:

**IMPORTANT NOTICE**

**Australian Quarantine Inspection Service  
Inspectors**

This package contains **preserved fragments of sponge specimens** (Phylum Porifera) of significant scientific value to the Queensland Museum (**CITES registered institution AU020**, Animal Ethics Scientific User number 0058).

Sponges (Phylum Porifera) are **not** listed by CITES, they are **not** protected or threatened species, and they have **no commercial value**.

The samples do **not** represent any quarantine or health risk, and they are **not** dangerous goods.

The specimens have been **originally preserved in 70% ethanol**. They are now stored temporarily in 20% ethanol for shipping purposes, and are **UNRESTRICTED** under **SPECIAL PROVISION A58 of the IATA Dangerous Goods Regulations**.

They are securely heat-sealed inside several separate plastic bags. At least **80% of the airspace inside the specimen container is filled with preservative**.

If this shipment is opened and inspected, it is essential that the specimens are re-wrapped and securely sealed inside the plastic bags. Otherwise the specimen fragments will rapidly dry and become worthless.

---

**If damaged or undeliverable return postage guaranteed to:**

Head of Biodiversity Program  
Queensland Museum  
PO Box 3300  
Grey Street  
South Brisbane, Q 4101  
Australia

CITES Institution AU020

## 8. RECOMMENDED READING

**Ackers, R.G., Moss, D. & Picton, B. (1992).** *Sponges of the British Isles ("Sponge V"). A colour guide and working document.* Marine Conservation Society, 9 Gloucester Rd., Ross-on-Wye, Herefordshire, HR9 5BU. 1992 Edition. Pp 1-175. [Provides a good glossary, illustrations of characters, and examples of descriptions].

**Bergquist, P.R. (1978).** *Sponges.* Hutchinson: London. Pp 1-268. [This is still the best general text available on Porifera, even though it is now out of date for much of the taxonomy and some theories on sponge biology].

**Boury-Esnault, N. & Ruetzler, K. (Eds) (1997).** *Thesaurus of sponge morphology.* Smithsonian Contributions to Zoology (596): 1-55.

**Brien, P., Lévi, C., Sarà, M., Tuzet, O & Vacelet, J. (eds) (1973).** *Spongiaires. Traité de Zoologie. Anatomie, Systématique, Biologie.* Masson et Cie: Paris. Volume 3. Pp 1-716. [This is a much more detailed, specialist treatise on sponge biology, but contains good general information on many aspect of the phylum. Once again, though, much is out of date].

**Hartman, W.D. (1982).** *Porifera.* Pp. 640-666 In: **Parker, S.P. (ed.)** *Synopsis and Classification of Living Organisms.* New York: McGraw-Hill. Volume 1. [The first comprehensive description of the family level classification for the Porifera (although the Calcarea section follows Burton (1963) and is completely rejected). Major revisions of some orders (Poecilosclerida, Halichondrida) have been subsequently undertaken and thus this work is now partially out of date].

**Hooper, J.N.A. & Wiedenmayer, F. (1994).** *Porifera.* In: **Wells, A. (ed.)** *Zoological Catalogue of Australia.* AGPS: Canberra. Volume 12. Pp 1-621. (updated online version 2004 <http://www.environment.gov.au/biodiversity/abrs/online-resources/fauna/afd/groups>) . [This provides family diagnoses and discussions on sponge taxonomy, in a contemporary framework, as it relates to the Australian fauna only. Provides biographical and bibliographical information on every named Australian species (although only 30% have yet been described), but not much use for identifying below the family level. Keys to genus level are provided in the online version].

**Hooper, J.N.A. & Soest, R.W.M. van (eds) 2002.** *Systema Porifera. A Guide to the classification of sponges* Vols 1&2, xlviii 1708pp (Kluwer Academic/ Plenum Publishers: New York, Boston, Dordrecht, London, Moscow). (<http://www.springer.com/life+sci/zoology/book/978-0-306-47260-2>)

**Hooper, J.N.A. 2008.** *Sponges.* Pp 170-186. In **P. Hutchings, M.J. Kingsford & I.O. Hoegh-Guldberg (eds).** *The Great Barrier Reef: Biology, Environment and management.* (CSIRO Publishing: Melbourne.) [Provides an overview of the coral reef inhabiting sponges of the Great Barrier Reef, but no taxonomic information]

## 9. GLOSSARY.

**acantho-** - with spines.

**accessory spicules** - old term referring to echinating megascleres (cf. principal, auxiliary spicules).

**actine** - see monactine.

**amphiblastula larva** - larval form associated with viviparous development, with an internal cavity and at least some cytological development, with flagella on anterior hemisphere only.

**anastomosing** - reticulated, rejoining, referring to cross connections between fibres of tracts.

**aniso-** - asymmetrically-ended spicule (e.g. anisoxea).

- aphodal** - (a) a small canal which joins the choanocyte chambers to an exhalant canal (cf. prosodal); (b) a condition of the aquiferous system in which the choanocyte chambers are joined to the inhalant system directly by a pinacocyte prosopyle, lacking prosodal canals (cf. diplodal, eurypylous).
- apopyle** - an aperture through which water leaves a choanocyte chamber (cf. prosopyle).
- aquiferous system** - the water conductive (circulatory) system extending from the inhalant pores (ostia) to exhalant pores (oscula).
- archaeocytes** - a motile amoeboid cell roaming within the mesohyl of the sponge, with at least 1 nucleolus and many phagosomes, capable of phagocytosis and able to develop into any other sponge cell type; also known as nucleolate cells.
- arenaceous** - condition of skeletal architecture in which sand and/or foreign spicule debris partly or completely replaces native spicules within the sponge skeleton.
- asconoid construction** - simple tubular body-plan, without folding of the body wall, with the central cavity (atrium) lined by choanocyte chambers, and a single osculum at the apex (characteristic of primitive Calcarea, also seen in a few homoscleromorph demosponges) (cf. syconoid, leuconoid).
- atrium** - exhalant water cavity leading to 1 or more exhalant canals (oscula); also known incorrectly as cloaca.
- auxiliary spicules** - old term referring to second and third categories of megascleres usually found outside the fibres, dispersed between tracts or on the surface; incorrectly interchanged with the terms "ectosomal" and "subectosomal spicules" (cf. accessory, principal spicules).
- axial canal or filament** - central lumen of a spicule, occupied in life by an organic filament.
- axial skeleton** - organic and/or inorganic skeleton found in the centre or axis of the sponge (cf. extra-axial).
- axial construction** - see condensed skeleton.
- axon or -actine** - number of geometric axes of a spicule.
- auto-dermal, auto-gastral spicules** - tetractinal spicules lying on or below the surface of the exterior (dermis) or interior (gastral) cavity, with the asymmetrical free ray directed outwards (Hexactinellida).
- basopinacocytes** - outer layer of epithelial cells covering the basal surface, at the point of contact with the substrate (cf. exopinacocytes).
- benthic** - living on the bottom of the sea; benthos refers to life forms on the sea bed.
- bioerosion** - chemical and physical degradation of an organic substrate caused by an association with another organism.
- body plan** - grade of construction of sponge body based on the complexity of the aquiferous system and disposition of choanocyte chambers and interconnecting canals (see asconoid, syconoid, leuconoid, aphodal, diplodal, prosodal); (not to be confused with the terms body shape or growth form).
- centrangulate** - sharp bend or angular curve at the centre.
- choanocyte** - collar-cell bearing a flagellum surrounded by a collar of cytoplasmic microvilli, used to produce a water current system and entrapment of small food particles or colloidal material.
- choanocyte chamber** - cavity lined by spherical clusters of choanocytes with flagella directed into the water-filled lumen (Demospongiae, Calcarea) (cf. flagellated chamber of Hexactinellida).
- choanoderm** - strictly a continuous layer of choanocytes lining a single internal cavity (found only in some Calcarea); also in a generalized sense to include all internal surfaces not bound by exo- or basopinacocytes (24).
- choanosome** - region of the sponge containing choanocyte chambers, which includes everything bounded by the pinacoderm; also known as endoderm or endosome (cf. ectosome).
- choanosomal spicules** - condition referring to localization of megascleres within (coring) spongin fibres or tracts (cf. ectosomal and subectosomal spicules).
- coeloblastula larva** - heterogenous assemblage of larval forms associated with oviparous development, with a cytologically undifferentiated central region, and an even distribution of small flagella.
- collagen** - proteinaceous material forming (a) the intercellular connective "tissue"/ ground substance/ matrix within the mesohyl, formed of minute fibrils which are visible only through electron microscopy, and collectively called spongin type A; and (b) the macroscopic spongin fibres producing the organic skeleton; collagen fibrillogenesis is universal within the Porifera.
- collagenous filaments** - (or collagen fibrils) intercellular fibrils produced by cellular secretion (fibrillogenesis) forming the ground substance or spongin type A matrix within the mesohyl; 2 forms are recognized, rough and smooth, both requiring electron microscopy to elucidate their structure.
- condensed or compressed** - condition of skeletal architecture in which there is a compressed central axis of fibres and/or spicules, from which arises plumose or plumoreticulate columns of fibres and/or spicules; also known as axinellid or axinelloid.
- coring spicules** - spicules found inside (coring) spongin fibres (cf. echinating spicules).
- dendritic** - condition of skeletal architecture whereby spongin fibres branch but do not rejoin with each other (i.e. non-reticulate).
- dermal** - strictly refers to any association with the pinacoderm; also used to refer to structures lying on or just below the ectosomal membrane or dermis (correct usage is "ectosomal").

- diactinal** - spicules with 2 diverging rays, representing growth in 2 directions, usually with bilateral symmetry; diacts may include monaxonic spicules (e.g. oxeas of demosponges), and tetraxonic derivatives (e.g. "oxea" of Calcarea; uncinata of Hexactinellida) (cf. monactinal).
- dictyonal framework** - rectangular mesh formed by fused spicules or lychniscs joined together (Hexactinellida).
- dioecious** - with the cells of each sex occurring in different individuals (also known as gonochoristic), but in sponges it is usual for one individual to produce eggs at one time and sperm at another times (strictly successive or temporal hermaphroditism) (cf. hermaphroditic).
- diplodal** - a condition of the aquiferous system, where some sponges possess both prosodal and aphodal canals between choanocyte chambers (cf. aphodal, eurypylous).
- echinating spicules** - spicules with one end, usually the head, implanted in a spongin fibre or a spicule column and standing more-or-less perpendicular to the column (found in Poecilosclerida) (cf. coring spicules).
- ectosome** - peripheral region of the sponge lacking choanocyte chambers; the term strictly refers to the unicellular surface layer (pinacocytes), but it is also used to refer to the mineral skeleton found in the periphery; also known as cortex or dermis (cf. choanosome).
- ectosomal spicules** - condition referring to localization of megascleres to the ectosomal skeleton (cf. subectosomal, choanosomal spicules).
- extra-axial** - organic and/or inorganic skeleton arising from the centre (or axis) and ascending towards the periphery of the sponge (cf. axial).
- eurypylous** - condition of the aquiferous system in which there are wide mouthed sac-like choanocyte chambers without any aphodal canals present (cf. aphodal, diplodal conditions).
- exhalant** - part of aquiferous system related to the expelling of water from the sponge, and includes all water vascular structures between the apopyles and the oscula; also known as excurrent system (cf. inhalant).
- exopinacocytes** - outer layer of pinacocyte cells covering the free surface of the sponge (cf. basopinacocytes).
- fibres** - (macroscopic) discrete column of spongin, forming the organic skeleton (see spongin fibres).
- fibrils** - (sub-light microscopic) collagenous filaments forming the spongin ground substance (see collagen fibrils).
- filter feeding** - process of obtaining food by pumping water through a series of sieves of decreasing size, finally obtaining small food particles for ingestion usually less than 0.1 µm in diameter.
- fistule** - tubular structure, on the upper surface of some sponges, on which the oscule is situated, used to exhale water; frequently found on species that burrow into mud or excavate coral.
- flagella** - the central organelles of choanocyte cells, used to set up a water current via rhythmic beating and aid in entrapment of food particles.
- flagellated chambers** - cylindrical chambers lined by choanocytes, which are not embedded within a cellular matrix, and also lack any connecting canals (Hexactinellida only) (cf. choanocyte chambers of Demospongiae and Calcarea).
- fusiform** - spicule tapering regularly towards one or both ends (cf. hastate).
- gastral** - associated with the central atrium or gastral cavity (Hexactinellida) (cf. dermal, parenchymal).
- gonochoristic** - male and female cells produced by different individuals (cf. hermaphroditic).
- ground substance** - see collagen.
- habit** - term used to describe external shape of a sponge, also known as ecophenotype.
- halichondroid** - condition of skeletal structure, with megascleres arranged in vague tracts which may be reticulate or scattered in a disorganised criss-cross within the mesohyl.
- hastate** - spicules with abruptly tapering ends (cf. fusiform).
- hermaphroditic** - male and female cells occur together in one individual at the same time (cf. gonochoristic).
- hexact** - spicule with 6 rays (Hexactinellida).
- hymedesmoid** - condition of skeletal architecture found in encrusting sponges, in which there is a flattened basal layer of spongin lying on the substrate, and spicules stand erect on (echinate) this basal layer.
- hypo-dermal, hypo-gastral spicules** - tetractinal spicules lying on or below the exterior surface or the gastral cavity, with the asymmetrical free ray directed inwards (Hexactinellida).
- inhalant** - part of the aquiferous system related to bringing water into the choanocyte chambers, including all structures between the ostia and prosopyles; also known as incurrent system (cf. exhalant).
- isodictyal** - condition of skeletal architecture in which the reticulation is triangular in 3-dimensions, produced by single spicules joined together at their ends (nodes) by an accretion of collagenous spongin.
- isotropic** - condition of skeletal architecture in which there is a disoriented or seemingly random reticulation of spicules or fibres without distinction between primary and secondary columns.
- junior synonym** - used in the scientific sense, refers to a proper scientific name given to a particular species that already has a valid (older) scientific name, in which case the junior synonym is not recognised as being valid by convention.
- keratose sponges** - collective term referring to sponges which lack a native mineral skeleton (usually only includes the orders Dictyoceratida, Dendroceratida, Verongida).



- leuconoid** - body-plan construction produced by complex folding of the body wall, forcing choanocyte chambers to become oval and isolated in a maze of canals within the body wall, and chambers open onto branching excurrent canals (most Demospongiae, some Calcarea) (cf. asconoid, syconoid).
- matrix** - see collagen.
- marginal prostals** - spicules supporting and projecting around the oscula (Hexactinellida).
- megascleres** - larger size of spicules forming the sponge skeleton; also known as structural spicules (cf. microscleres).
- mesohyl** - intercellular compartment in sponges, equivalent to the mesenchyme of other metazoans, including the region bounded by the pinacoderm and choanoderm.
- microcionid** - condition of skeletal architecture found in encrusting sponges, in which non-anastomosing (plumose) spongin fibre nodes arise from a basal layer of spongin lying on the substrate, and these are echinated by (usually perpendicular) plumose tracts of spicules.
- microscleres** - smaller category of spicules forming the sponge skeleton; also known as flesh spicules (cf. megascleres).
- microvilli** - extensions of the choanocyte cell which form an upright tube or collar surrounding the central flagellum, and used as in food entrapment and water flow.
- monactinal** - a spicule with 1 ray, growing from 1 end only, usually asymmetrical in geometry; monacts include monaxonic spicules (e.g. styles in demosponges), derivatives of tetraxonic spicules (e.g. "needle-eye" microxea in Calcarea) and hexactinal spicules (e.g. basal bidentates); (cf. diactinal).
- monaxonid** - linear spicule with no more than 2 rays along 1 axis, including both monactinal and diactinal spicules; also known as monaxonic (cf. triaxonid, tetraxonid).
- multispicular** - more than 1 row of spicules in a fibre, tract or reticulation; also known as polyspicular (cf. unispicular).
- oscula** - exhalant pores, through which water leaves the sponge; usually represented as the larger pores (cf. ostia).
- ostia** - inhalant pores, through which water enters the sponge (cf. oscula).
- ovipary** - method of sexual reproduction in which eggs develop within the female sponge, are broadcast into the water, often becoming attached to a mucous layer on the external surface, they are fertilized externally, larvae are subsequently released, are free for varying periods and eventually settle on the substrate (cf. vivipary).
- parenchymal** - associated with the interior of the skeletal framework (trabeculae) (Hexactinellida).
- parenchymella larva** - larval form associated with viviparous development, with an even covering of minute cilia or flagella, often with considerable cytological differentiation including juvenile spicules.
- pentact** - radiate spicule with 5 rays (found in most Hexactinellida, but also occurring in some demosponges as modified calthrops).
- peripheral skeleton** - see ectosome.
- pinacocyte** - outer layer of highly flattened anucleolate epithelial cell forming the external (exopinacocyte) and basal (basopinacocyte) surfaces.
- pinacoderm** - outer (ectosomal) layer of the sponge formed by pinacocytes (Demospongiae, Calcarea) or syncytial "tissue" (Hexactinellida).
- pith** - central diffuse region within a spongin fibre.
- pleural prostals** - spicules projecting laterally from the sponge (Hexactinellida).
- plumoreticulate** - condition of skeletal architecture whereby main tracts of spicules and/or fibres diverge in plumose fashion and secondary tracts are interconnected.
- plumose** - condition of skeletal architecture in which spicules and/or fibres diverge, usually in ascending tracts with the points of spicules projecting outwards, but do not rejoin.
- polyact** - spicule with more than 6 rays (microscleres).
- Porifera** - Phylum of animals, known collectively as sponges, in the subkingdom Parazoa, lying between the single-celled (Protozoa) and multicellular animals (Metazoa).
- porocyte** - modified pinacocyte cell lining the pores of the inhalant and exhalant canal systems.
- primary fibre or tract** - major fibre or spicule tract usually ascending to the surface at right angles (cf. secondary).
- principal spicules** - old term referring to the largest or main category of structural megascleres often (but not exclusively) found within (coring) fibres or primary tracts (cf. accessory, auxiliary spicules).
- prosopyle** - an aperture through which water enters the choanocyte chamber.
- prosodal** - a condition of the aquiferous system in which a small canal joins the choanocyte chambers to an inhalant canal (cf. aphodal).
- prostals** - projecting spicules (see pleural and marginal prostals) (Hexactinellida).
- radiate** - condition of skeletal architecture whereby spicules are oriented radially from the centre (axis) of the sponge; sometimes only visible at the surface; also known as radial or choristid structure.
- renieroid** - condition of skeletal architecture in which there is a regular reticulation of single (or few) spicules forming square meshes, joined together at their ends (nodes) by an accretion of collagenous spongin.

- reticulate** - condition of skeletal architecture whereby spongin fibres and/or spicule columns branch and rejoin (anastomose) with each other to form 2- or 3-dimensional meshes.
- sclerocyte** - anucleolate motile secretory cell which produces spicules.
- secondary fibre or tract** - minor fibre or spicule tract interconnecting the ascending primary fibres or tracts (cf. primary).
- sedentary animals** - (or sessile) animals in which the adults do not move by usual forms of locomotion (cilia, pseudopods, legs, etc.), but usually live attached to the substrate. Adult sponges are typically sedentary, although their larvae swim through the water column using cilia and/or flagellae.
- spicule** - discrete element of the skeleton, usually mineralized (silica or calcite), produced by sclerocytes; divided into two categories based on size (megasclere and microscelere).
- spongin** - proteinaceous material composed of collagen, forming the organic intercellular matrix (collagenous filaments or spongin type A), and organic skeleton (spongin fibres or spongin type B).
- spongin fibre** - macroscopic collagenous structures made up of many small microfibrils bound together, producing discrete stands or plaques; fibres may be homogeneous (e.g. Spongiidae), have a light central pith (e.g. Thorectidae) or a granular medullary portion (e.g. Verongida); fibres frequently contain the mineralized secreted products of the sponge (spicules) and/or foreign particles (e.g. arenaceous species); also known as the organic skeleton.
- spongocytes** - motile nucleolate cells that secrete spongin fibres.
- subectosomal spicules** - condition where megascleres are localized to a region below the ectosomal skeleton but not associated with fibres or primary skeletal tracts (cf. ectosomal, choanosomal spicules).
- subisodictyal** - condition of skeletal architecture similar to isodictyal reticulation but where meshes have 2 or more spicules per side.
- syconoid construction** - body plan produced by folding of both the exterior (pinacoderm) and interior (choanoderm) walls, such that choanocyte chambers lie within the body wall, and chambers open directly onto the atrium (Calcarea).
- syncytial** - where the living "tissue" on the external surface (pinacoderm) or within the internal surface (choanoderm) consists of an acellular protoplasm with multiple nuclei, usually stretched across a skeletal framework (Hexactinellida).
- tangential** - group of fibres or spicules arranged parallel to the surface.
- tetract, tetractinal** - spicules with 4 rays (found in some Demospongiae, Hexactinellida and Calcarea).
- tetragonid** - spicule with 4 rays each containing a central axis; also known as tetraxonic (cf. monaxonid, triaxonid).
- trabeculae** - fibre, tract or bundle of spicules with angular cross section (Demospongiae); spicular framework forming the hexactinellid skeleton, also known as "plugged bridges", across which syncytial "tissue" is stretched (Hexactinellida).
- triact** - spicule with 3 rays (common in Calcarea).
- triaxonid** - spicule with 3 perpendicularly intersecting axes; also known as triaxonic (cf. monaxonic, tetraxonic).
- type locality** - original locality from which the original specimen of the species, called the holotype, was described.
- unispicular** - single row of spicules in a tract, fibre or reticulation (e.g. isodictyal) (cf. multispicular).
- vivipary** - method of sexual reproduction whereby the female sponge takes in sperm from another sponge via the inhalant aquiferous system, eggs are fertilized and the ciliated (parenchymella) larvae are brooded within the female sponge, and fully developed larvae, usually well-differentiated cytologically, are subsequently released into the seawater (cf. ovipary).