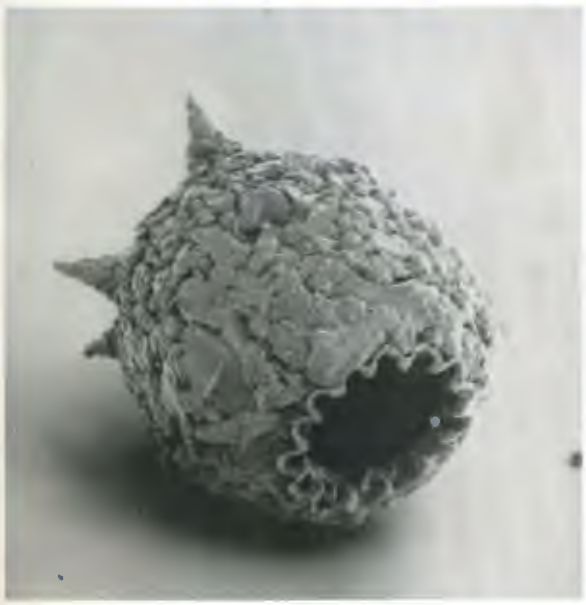
An Atlas of FRESHWATER TESTATE AMOEBAE

C.G. Ogden and R.H. Hedley



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Introduction

The term 'testate amoebae' is given to those amoebid protozoa (Protozoa: Sarcodina: Rhizopodea) in which the cytoplasm is enclosed within a discrete shell or test, and which extrude filose pseudopodia. Testate amoebae, also known as thecamoebae, are present in a wide range of moist and freshwater habitats from moss, soil, peat, and standing water to sewage-treatment works. They are most commonly found in any moist situation where there are mosses, even occurring above ground level on the barks of trees and on the roofs of buildings. This handbook is intended as a field and laboratory guide to the common British species. As an aid to identification details of the structure of the shell are provided together with brief reviews of the biology and ecology of these animals. A classification is also included. At present there are more than one hundred and fifty species recorded from the British Isles, of which about two-thirds are illustrated in this Atlas using scanning electron micrographs. The micrographs are shown at magnifications within the range of most optical microscopes and consequently will be of value to investigators who do not have access to electron microscopes.

The species illustrated in this handbook were collected from several localities in southern England, particularly Cranes Moor and Mately Bog in Hampshire. The majority of the specimens studied were wild material obtained from *Spagnum* mosses, others came from clonal cultures of several species which are maintained for study purposes in this laboratory. A number of these cultures have already been used for more detailed biological investigations (Hedley & Ogden, 1973, 1974*a*; Hedley *et al.*, 1974, 1977) and samples have been deposited at the Culture Centre of Algae and Protozoa, The Natural Environmental Research Council, Cambridge. Extensive use was also made of the collection of testate amoebae, many of which were identified by Penard (see below), available for reference in the Department of Zoology, British Museum (Natural History).

Monographs have been published on the Rhizopoda of North America by Leidy (1879), and of central Europe—particularly Switzerland—by Penard (1890, 1902). Mr James Cash initiated a similar work to cover the British fauna and five volumes dealing with British Rhizopoda and Heliozoa were published between 1905 and 1921 by the Ray Society, London. Following Cash's death in 1909, the three remaining volumes were completed by Mr G. H. Wailes and Cash's assistant, Mr J. Hopkinson. The works of Leidy, Penard and Cash *et al.*, contain many excellent descriptions and illustrations, the detail of which is remarkable considering that they were working close to the limit of the resolving power of the optical microscopes

available to them at that time. Since the majority of testate amoebae appear to be cosmopolitan, these monographs have become standard reference works. In this Atlas we have sought to complement the comprehensive bibliographies provided by Cash *et al.*, by listing only the more recent references to the literature.

With the development of the scanning electron microscope it is now possible to examine the surface features of testate amoebae, which range in size between 20 and 400 μm, in greater detail at both low and high magnifications with increased resolution and depth of field. Other studies using transmission electron microscopy on sectioned material provide additional information on the cellular organisation and structure of these protozoa. The addition of energy dispersive X-ray analytical equipment to these microscopes, allows qualitative elemental analyses to be made of the shell structures.

Specimens for examination by scanning electron microscopy are first cleaned individually by transference through distilled water using a single-hair brush. Next, each is placed on a small drop of Araldite on a cover slip previously cleaned with acetone and lint-free tissue. The prepared cover slip can then be mounted on a stub with either an electrically conductive paint (Silver Dag) or Araldite, and coated evenly with gold in a vacuum coating unit. The photomicrographs reproduced in this Atlas were obtained from an examination of these stubs using a Cambridge Stereoscan Mk II operating at 10 kV, and were recorded on Ilford HP4 film.

We wish to acknowledge the valuable assistance provided by Mrs N. J. Mordan during the initial stages of this work, and various colleagues who kindly collected samples.

Biology and Ecology

Shell

Shells of testate amoebae may be proteinaceous, agglutinate, siliceous or calcareous in composition, and normally consist of one chamber with a single aperture.

Proteinaceous shells

These shells are of two main types: those in which the shell wall is constructed of numerous alveoli or building blocks, as in some species of *Arcella* and *Centropyxis*, and those in which the shell wall is composed of an homogenous layer of material. The secretion and formation of the alveoli has been described for *Arcella vulgaris* var. *multinucleata* and *Centropyxis discoides* (Netzel, 1975*a*, *b*, *c*; 1976*a*). The daughter alveoli are formed in the cytoplasm of the parent prior to division. Then at the onset of division a pseudopodial sheet extends from the aperture of the parent to form an enclosed chamber, inside which the daughter alveoli are arranged to form a replica of the parent shell. When the daughter shell is complete the cytoplasmic sheet is withdrawn and the cell divides by binary fission.

Examination of fractured shells of *Arcella arenaria* and *A. discoides* has shown that each alveolus is surrounded either by a thick or thin wall, but apparently lacks contents. However, it has recently been demonstrated that alveoli of *Arcella* and *Centropyxis* often contain inorganic elements which may be used to strengthen the shell wall (Hedley *et al.*, 1976). For example, the alveoli of *Centropyxis hirsuta* are rich in amorphous manganese, whilst *Arcella* species have the alveolar contents enriched with iron. This inorganic material is not usually present in the alveoli of young animals, and in dried specimens the shell surface may have small pits or depressions. The pits or depressions are especially evident in specimens of *Arcella*, where the margins of the alveoli are often delimited by small pores (see page 35). The shell wall of *Arcella discoides* has been reported to contain several amino acids which are similar to those found in the organic cement of agglutinate marine foraminifera, and the term 'pseudochitin' is sometimes used to describe this material (Hedley, 1963; Moraczewski, 1971).

Information on the second type of proteinaceous shell, which has the appearance of a smooth continuous coat (see page 73) is based on two reports. The shell wall of *Hyalosphenia papilio* is apparently homogenous and composed of mucoprotein which appears uniformly electron dense in stained sections (Joyon & Charret, 1962). The shell of an unidentified species of *Difflugiella*, on the other hand, is composed of three layers only one of which is electron dense (Griffin, 1972).

Agglutinate shells

Agglutinate forms may be divided into two groups.

The first group contains most of the family Difflugiidae. These amoebae select quartz grains, whole diatoms or pieces of diatoms, from the environment and use them to construct a daughter shell, identical in size and shape to the parent. Some species appear superficially to have a shell composed of randomly arranged particles, however, close examination reveals that at least one area, usually the aperture, has a specific pattern of organisation. In *Difflugia corona*, for example, the particles are arranged in a tooth-like pattern around the aperture. *D. lanceolata* selects only flat faced particles to make its shell, whilst *D. bacillifera* appears to prefer diatom shells. At the onset of division in *Difflugia corona* the mass of siliceous particles which have been collected by the parent are arranged around a cytoplasmic extrusion (Jennings, 1937). As this cytoplasm extends the particles mix with a liquid secretion and cover the surface to produce the new shell. Initially the shell is soft but soon hardens. The fine structure of the cement or glue used by an allied species *Difflugia lobostoma* has been described by Eckert & McGee-Russell (1974) and appears similar to that of *Euglypha* (Hedley & Ogden, 1973, 1974*b*).

The second type of agglutinate shell occurs in the genera *Nebela* and *Heleopera*. It is generally agreed that these genera do not make their own shell plates but use those which are obtained following the ingestion and digestion of smaller siliceous testates, usually members of the superfamily Euglyphacea, on which they prey. Two sources of shell plates are available, the plates that are glued together forming the shell chamber, and the separate reserve plates stored in the cytoplasm of the vegetative animal. In *Nebela collaris* the shell plates obtained by ingestion are usually found in large numbers scattered throughout the cytoplasm (MacKinlay, 1936), unlike typical reserve plate formation where the plates congregate in the region of the nucleus. When *N. collaris* was cultured in the absence of other testate amoebae, Mackinlay observed that they produced daughter shells which were devoid of shell plates.

The pattern of shell plates is usually distinctive for different species of *Nebela* and *Heleopera*. *Nebela dentistoma*, for example, has its shell plates arranged so that they do not overlap, and a patterned structure is evident in the organic cement that joins them (see page 97). Chemical analysis of whole shells of *Nebela dentistoma, N. tincta, N. tubulosa* and *Heleopera rosea* has shown that they are composed mainly of inorganic calcium, potassium, silicon and iron. Since the shell plates themselves are siliceous, the other elements are probably constituents of the organic cement matrix, and the significant amounts of iron found in *Heleopera rosea* probably account for the colouration of the shell.

Siliceous shells

All members of the Euglyphacea make their own siliceous shells as do some species of the genera *Difflugia*, *Lesquereusia* and *Quadrullela*. The siliceous, oval or circular shell plates of the Euglyphidae are formed prior to cell division and are stored in the cytoplasm close to the nucleus of the vegetative adult (Hedley & Ogden, 1973,

1974*a*). As many as four different types of plates or spines can be produced by one species. At division, cytoplasm is extruded from the aperture of the parent and the reserve shell plates move from the parent's cytoplasm to a position around the cytoplasmic extrusion. The cytoplasmic extrusion is strengthened by a central core of microtubules, and the shell plates are held at the end of finger-like processes by adhesion plaques of concentrated microfilaments. The shell plates are first arranged in a regular sequence, often in longitudinal rows, later they assume the identical pattern to the parent and are fixed by organic cement (Hedley & Ogden, 1974*b*). Only a small amount of cement is usually required to hold the plates in position and maintain the specific shape, but more cement is present at junctions between shell plates and spines or other projections. *Lesquereusia* and *Quadrullela* undergo a similar process of division. In *Lesquereusia* the shell is made of siliceous rods, whilst in *Quadrullela* the plates are quadrangular. A few species of *Difflugia* also make their own siliceous elements. In *D. oviformis*, for example, siliceous particles called idiosomes are manoeuvered around a cytoplasmic extension at division until they are arranged to form a single layer which is identical to the parent shell. Division of the parent cytoplasm takes place when the daughter shell is complete (Netzel, 1972, 1976*b*, 1977).

In siliceous testate amoebae specific differences appear to be restricted to the shape and size of the siliceous elements and the structure of the organic cement. The Euglyphacea and *Quadrullela* have siliceous elements which either overlap or are packed close together, and the organic cement is seen only in those species which have an organic collar around the aperture. In *Lesquereusia* and *Difflugia oviformis* on the other hand the cement is found at the interstices of the siliceous elements where it is often arranged in a distinctive pattern (see page 87).

Calcareous shells

Only two species, *Paraquadrula irregularis* and *Cryptodifflugia oviformis* are reported as having calcareous shells. *Paraquadrula irregularis*, has quadrangular shell plates (Penard, 1903) and divides in a similar manner to the siliceous forms (Deflandre, 1953). The shell of *Cryptodifflugia oviformis* has been described as having a smooth outer surface and a wall made up of two uniform layers, a thin organic outer layer and a thick inner layer of amorphous calcium phosphate (Hedley *et al.*, 1977). It was suggested that the organic layer is produced at the onset of division to form an identical daughter shell, and that the calcareous layer forms later inside this organic layer.

Cytoplasm

The cytoplasm usually fills the chamber in smaller testate amoebae such as *Euglypha* (Fig. 1) and *Trinema*, whereas in larger species of *Nebela* and *Difflugia* it only partially fills the chamber and thin cytoplasmic strands attach it to the shell wall. The following information is based mainly on studies of proteinaceous, calcareous and siliceous amoebae. Reports relating to the cytoplasm of agglutinate species is sparse,

since their thick shells composed of quartz grains and diatom frustules are often opaque, and impose practical difficulties for both observation and sectioning.

A plasmalemma surrounds the cytoplasm. Pellicular microtubules or microfilaments, which may function as a cytoskeletal structure, sometimes lie beneath the plasmalemma. Ovoid or spherical mitochondria with tubular cristae and dense granular matrices, are distributed throughout the cytoplasm. The nucleus, which is normally spherical, is surrounded by two unit membranes with nuclear pores. The nuclear matrix is finely granular with small scattered concentrations of chromatin. The nucleolus is of variable shape, usually situated centrally in the nucleus, and stains densely (Fig. 1). The outer nuclear membrane is continuous with cisternae of the granular endoplasmic reticulum which forms a compact mass around the nucleus. This region appears more heavily stained than the surrounding cytoplasm because of the high concentration of ribosomes. One or more Golgi complexes are found in the perinuclear region, usually bordering the dense endoplasmic reticulum. In addition to the established role of packing secretory products, the Golgi bodies are believed to be involved in the formation of proteinaceous alveoli, organic cement and siliceous shell plates.

Contractile vacuoles occur close to the plasmalemma and discharge into the shell cavity. These vacuoles are often surrounded by numerous vesicles which are associated with the lumen of the vacuole. The fusion of these vesicles with the vacuole causes it to dilate slowly—'diastole', this is followed by the rapid collapse of the vacuole—'systole' as it discharges its contents. Microbodies or peroxisomes may also be present in the cytoplasm; each is enclosed in a single unit membrane and has a dense granular matrix containing tubular or lattice-like elements. The microbodies secrete the oxidative enzyme catalase, as well as other enzymes, and it is thought that they are ancillary sites for carbohydrate oxidation and therefore involved with energy production (Hruban & Rechcigl, 1969). Food vacuoles are formed by a process known as phagocytosis, when cytoplasm flows around and engulfs prey and food particles. After digestion and absorption of soluble materials, any residue is discharged from the vacuoles through the surface membranes. Food vacuoles usually occur near the aperture.

Other cytoplasmic vacuoles and vesicles are sometimes present and may be distinctive of a particular species, genus or larger group of amoebae. For example, in two species with siliceous shells, *Euglypha rotunda* and *Trinema lineare*, there are large electron-dense vacuoles situated anterior to the endoplasmic reticulum, vesicles containing reserve shell plates in the peripheral cytoplasm anterior to the nucleus, and vesicles containing organic cement scattered throughout the cytoplasm (Hedley & Ogden, 1973, 1974*a*). Netzel described (1975*b*, *c*; 1976*a*) electron-dense membrane bound granules in *Arcella vulgaris* and *Centropyxis discoides*, which he suggested may be used in the construction of proteinaceous shells. A storage area for acid mucopolysaccharide material has been described in the calcareous species *Cryptodifflugia oviformis* by Hedley *et al.* (1977), as well as large electron-dense inclusions of calcium occurring in the mitochondrial membranes.

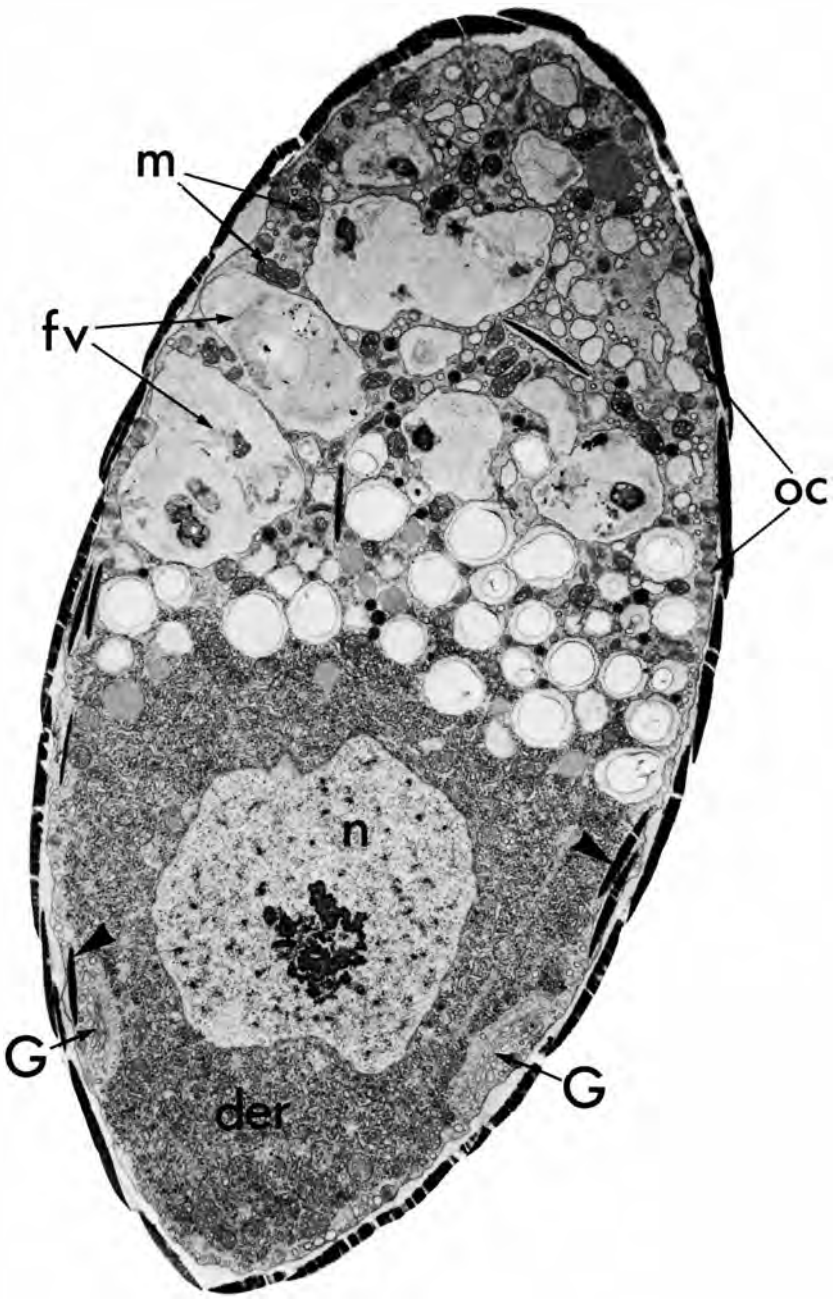


Fig. 1 Longitudinal section of the siliceous testate amoeba, *Euglypha rotunda*, showing the position of the nucleus (n) lying in the region of dense endoplasmic reticulum (der); Golgi complexes (G); mitochondria (m) and food vacuoles (fv). Note the reserve shell plates (large arrows) in the cytoplasm and the peripheral vesicles containing organic cement (oc).

Pseudopodia

Movement by testate amoebae is achieved by flowing extensions of the cytoplasm which pass through the shell aperture and can adhere to the substratum. These pseudopodia are diverse in shape and mode of activity. They frequently contain microfilaments, and sometimes microtubules, strands of endoplasmic reticulum, mitochondria and small vesicles. Wohlman & Allen (1968) and Eckert & McGee-Russell (1973) have suggested that the microfilaments in the pseudopodia of *Difflugia* are associated with the construction and extension of these cytoplasmic processes. Recent work has shown that concentrations of microfilaments form adhesion plaques at points of contact between cells, or between cells and inert material. The rapid formation and dispersion of these structures seems to be associated with cell locomotion. Similar plaques have been observed in testate amoebae at points of contact between pseudopodia (Hedley *et al.*, 1977) and in cytoplasmic connections between individuals of two siliceous species (Hedley & Ogden 1973, 1974*a*).

The classification of the superclass Rhizopoda is based largely on the type of pseudopodia. The three basic forms of pseudopodium are lobose, filose, reticulose, these have led to the recognition of three classes of amoebae: Lobosia—typical naked amoebae, Filosia—typical testate amoebae, and Granuloreticulosa—typical foraminifera. Lobose pseudopodia occur either as a single or a few stout trunk-like extensions, normally with rounded ends (Fig. 2), but may also appear as a single fan-like structure with a ruffled border. Filose pseudopodia are relatively thin, straight, finely pointed, and one extension may have several smaller branches. Reticulose pseudopodia consist of a network or web of fine interconnected strands.

Reproduction

Reproduction is, so far as is known, by replication of the parent during asexual binary fission to form an identical daughter-cell. The doubling time of laboratory cultures is usually between two to four days (Hedley & Ogden, 1973, 1974*a*; Hedley *et al.*, 1974, 1977), although estimates of six to eleven days have been made for wild populations (Heal, 1964*a*; Lousier, 1974).

Ecology

Moss such as *Sphagnum* offers a particularly suitable habitat for testate amoebae (Heal, 1962). Zonation is quite a common feature of testate amoebae distribution, it is often related to habitat moisture content which has an important influence on activity (Lousier, 1974), to the presence or absence of zoochlorellae, and in the case of agglutinate species to the availability of particles for shell construction (Heal, 1962; Meisterfeld, 1977).

The distribution of testate amoebae in soil seems to be determined largely by the size of the pore spaces and the thickness of the soil water film, although they are usually more numerous in soils having a high organic rather than a high mineral content (Stout & Heal, 1967). A vertical distribution is present in most soil and *Spagnum* habitats, which is correlated to some extent with shell shape. The larger

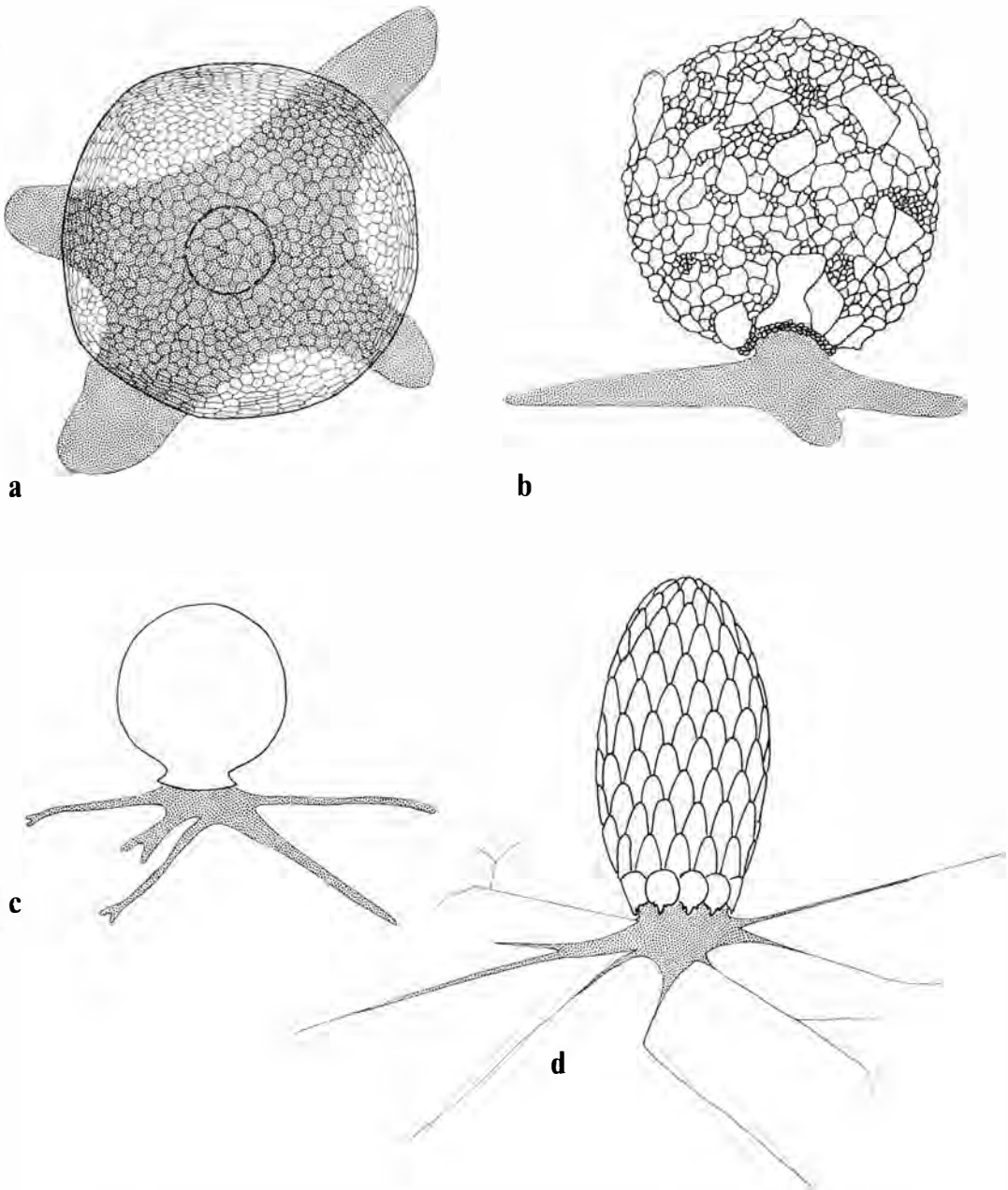


Fig. 2 Diagram illustrating the form of pseudopodia associated with different types of shell: (a) *Arcella vulgaris* with a proteinaceous shell, usually has about four lobose pseudopodia—but these may sometimes fuse to form a single fan-like pseudopodium with a ruffled edge (b) *Difflugia gramen* has an agglutinate shell and usually one or two large lobose pseudopods (c) *Cryptodifflugia oviformis* has a calcareous shell and the pseudopodia are recognised as being lobose, although, they appear to represent a transitional stage between lobose and filose structure (d) *Euglypha rotunda* with a siliceous shell shows a typical arrangement of filose pseudopodia.

and more spiney species are found in the upper soil horizons, and the flatter, smaller species in the lower horizons (Bonnet, 1964). Any attempt to estimate the biomass of testate amoebae is complicated by the presence of empty shells and cysts. Heal (1962) estimated that the biomass of live animals in a *Sphagnum* sward was 1 gm/m², and estimates for various soils have produced similar figures of 1–2 gm/m² (Volz, 1964; Heal, 1964*b*, 1965).

Testate amoebae can tolerate a wide range of temperatures and occur from the tropics to polar regions. Observations on a number of Russian soils showed that protozoan activity continued throughout the winter below the frozen topsoil layer (Stout & Heal, 1967). Live testate amoebae have also been found below 3 cms in moss-turf on Signy Island, Antarctica, when the air temperature was −10°C (Smith, 1973). In laboratory cultures amoebae have survived at temperatures from 4 to 35°C. Ecological surveys in temperature regions have failed to demonstrate any seasonal trends in population density (Couteaux, 1976).

There is some evidence that the distribution of testate amoebae is limited by pH (Graaf, 1956; Heal, 1961, 1964*b*). For example, different species groups occur on acid moors and in alkaline soils, with only a few species common to both habitats. It is possible, nevertheless, that the distribution of amoebae is influenced more by the growth of food organisms than by the acidity or alkalinity. Evidence on salinity tolerance is sparse, Golemansky (1974*a*, 1976*a*, *b*) and Chardez (1973) described littoral marine species from the Atlantic, Mediterranean and Black Sea, and in the laboratory cultures of *Cryptodifflugia oviformis* have been grown in saline media (Hedley *et al.*, 1977).

Food

Small testate amoebae feed mostly on bacteria, algae and fungi, and it has been suggested that yeasts may form a significant food source for soil-dwelling animals (Heal, 1963*a*). The larger species are thought to prey also on other protozoa, including other testate amoebae and small naked amoebae, and possibly rotifers (Mast & Root, 1916). The size of prey that can be consumed is often limited by the size of the shell aperture of the predator, although some large forms may project pseudopodia inside the shell of the prey and absorb the cytoplasm. Stump (1935) observed *Lesquereusia spiralis*, *Pontigulasia vas*, *Centropyxis constricta* and *Difflugia lobostoma* feeding on filamentous green algae by opening the algal cells and removing the contents. In a similar study on *Difflugia rubescens*, Hoogenraad & Groot (1941) found that this species had a preference for algae of the genus *Closterium* and described the way in which the testate punctured the cell wall and ingested the contents.

Cysts

Temporary or resistant cysts are formed at certain times, usually as a protection against adverse environmental conditions such as desiccation, exhaustion of food supplies or anaerobiosis. The cyst is contained within a cyst-membrane and usually lies against the shell wall in the aboral region, often with part of the membrane

forming a seal across the middle of the shell. In *Arcella*, and a few other genera, the aperture is sealed by a proteinaceous membrane, while some agglutinate species seal the chamber with a plug of siliceous particles. During encystment there is a reduction of the cytoplasmic volume, the number of organelles, and in siliceous species the reserve shell plates are discarded.

Classification

The classification adopted here is basically that proposed by Loeblich and Tappan (1964). In this, as in other recent classifications Deflandre (1953), Loeblich and Tappan (1961), two main criteria are used to divide the Superclass Rhizopoda; these are the cytoplasmic form of the pseudopodia and the structure of the shell. Division into classes is based on the characters of the pseudopodia, whilst the orders are separated on the presence or absence of a protective covering. Further divisions into superfamilies are based on the detailed structure of the shell. The few changes that are proposed here have been achieved within the framework of previously published names, and no new names are included. For the purposes of this study only those animals having a rigid shell have been considered, therefore the families Cochliopodiidae Taranek, 1882 and Microcoryciidae de Saedeleer, 1934 have been omitted.

A diagnosis based on the structure of the shell is given below for each family and genus that have been referred to collectively as testate amoebae:

Subphylum **SARCODINA** Hertwig and Lesser, 1874

Superclass **RHIZOPODEA** von Siebold, 1845
Locomotion associated with formation of lobopodia, filopodia or reticulopodia, or with protoplasmic flow without production of discrete pseudopodia.

Class **LOBOSIA** Carpenter, Parker and Jones, 1862
Pseudopodia lobose, or rarely filose but produced from a broader hyaline lobe, not anastomosing.

Order **ARCELLINIDA** Kent, 1880
With a shell or rigid external membrane, having a definite aperture for extrusion of lobose pseudopodia.

Superfamily **ARCELLACEA** Ehrenberg, 1843
Pseudopodia fingerlike.

Family **ARCELLIDAE** Ehrenberg, 1843. Shell circular of ovoid; composed of proteinaceous material, surface either smooth or pitted; aperture central, circular.

Genus *Arcella* Ehrenberg, 1832. Shell colourless, yellow or brown; circular or ovoid; in lateral view varying from plano-convex to hemispherical; surface either smooth or punctated, but may be moulded to have angular facets which sometimes develop into spines or prominences; wall composed of numerous alveoli made of a proteinaceous material, arranged in one or more layers; aperture central, circular, with a small collar, usually invaginated and occasionally surrounded by pores. . . . p. 24

Family **CENTROPYXIDAE** Jung, 1942. Shell circular, hemispherical or ovoid; usually laterally compressed at anterior margin; composed of proteinaceous material often with agglutinated mineral particles; aperture sub-terminal with recurved margin, circular or oval.

Genus *Centropyxis* Stein, 1859. Shell colourless, yellow or brown; circular, hemispherical or ovoid; in lateral view rounded posteriorly and tapering towards the anterior edge, which often has a recurved margin, conical spines sometimes present at lateral margins; surface either punctated or rough; wall composed of either numerous alveoli arranged in layers or agglutinated mineral particles; aperture sub-terminal or occasionally central, circular or oval and invaginated. . . . p. 46

Family **PLAGIOPYXIDAE** Bonnet, 1959. Shell circular or ovoid, bilaterally symmetrical; composed of agglutinated mineral particles; aperture sub-terminal elongate, usually with overhanging anterior lip.

Genus *Plagiopyxis* Penard, 1910. Shell grey, yellow or brown; circular or ovoid; composed of agglutinated mineral particles; aperture sub-terminal, elongated slit extending for about one third circumference of shell. . . . not illustrated

Genus ***Bullinularia*** (Penard, 1907). Shell, dark brown; circular or ovoid; composed of agglutinated mineral particles; aperture sub-terminal, elongated slit with lower lip depressed, upper lip incurved and perforated by rows of pores. . . . p. 64

Family **TRIGONOPYXIDAE** Loeblich and Tappin, 1964. Shell circular or hemispherical, radially symmetrical; composed of agglutinated mineral particles; aperture central.

Genus *Trigonopyxis* Penard, 1912. Shell brown; circular or hemispherical; composed of agglutinated mineral particles; aperture central, invaginated and triangular. . . . p. 66

Genus *Cyclopyxis* Deflandre, 1929. Shell brown; circular or hemispherical; composed of agglutinated mineral particles; aperture central, invaginated, circular. . . . p. 68

Family **HYALOSPHENIIDAE** Schulze, 1877. Shell ovoid or pyriform, laterally compressed; composed of either proteinaceous material or siliceous shell-plates, sometimes with agglutinated mineral particles; aperture terminal, either oval, linear or circular.

Genus ***Hyalosphenia*** Stein, 1859. Shell colourless, yellow or brown; ovoid or pyriform; composed of proteinaceous material; aperture terminal, oval. . . . p. 72

Genus ***Heleopera*** Leidy, 1879. Shell colourless, yellow, brown, red or purple; ovoid; composed of oval, circular or rectangular siliceous shell-plates and usually having agglutinated mineral particles in the aboral region; aperture terminal, linear, surrounded by an organic border. . . . p. 76

Genus ***Lesquereusia*** Schlumberger, 1845. Shell colourless; ovoid with an unsymmetrical neck; composed of siliceous curved rods sometimes with agglutinated mineral particles; aperture terminal, circular. . . . p. 82

Genus *Nebela* Leidy, 1875. Shell colourless, yellow or brown; ovoid or pyriform; composed of oval or circular or rectangular siliceous shell-plates, usually of mixed shapes and sizes; aperture, terminal, oval or circular, often with an organic border. . . . p. 88

Genus ***Quadrullela*** Cockerell, 1909. Shell colourless; ovoid; composed of quadrangular siliceous shell-plates; aperture terminal, oval. . . . p. 116

Genus ***Leptochlamys*** West, 1901. Shell colourless; ovoid; circular in transverse section; composed of proteinaceous material; aperture terminal, circular. . . . not illustrated

Family **PARAQUADRULIDAE** Deflandre, 1953. Shell ovoid; composed of quadrangular calcite shell-plates; aperture terminal, oval.

Genus ***Paraquadrula*** Deflandre, 1932. Shell colourless; ovoid; composed of quadrangular calcite shell-plates; aperture terminal, oval. . . . not illustrated

Family **DIFFLUGIIDAE** Wallich, 1864. Shell circular, pyriform, acuminate or ovoid; composed of agglutinated mineral particles and sometimes diatom frustules; aperture terminal, circular or lobed.

Genus ***Difflugia*** Leclerc, 1815. Shell colourless, yellow or brown; circular, ovoid, pyriform or acuminate; composed of agglutinated mineral particles and diatom-frustules; aperture terminal, circular or lobed, sometimes with an organic border. . . . p. 118

Genus ***Pontigulasia*** Rhumbler, 1895. Shell yellow or brown; ovoid or pyriform with a constriction to form a neck; composed of agglutinated mineral particles; aperture terminal, circular having an internal transverse diaphragm on level with neck constriction. . . . p. 162

Genus *Cucurbitella* Penard, 1902. Shell dark grey; ovoid; composed of agglutinated siliceous grains and plates; aperture terminal, circular and irregularly serrated, surrounded by a three- or four-lobed collar. . . . not illustrated

Genus *Sexangularia* Awerintzew, 1906. Shell elongate; composed of proteinaceous material, occasionally with agglutinated particles; aperture terminal, polyoganal. . . . not illustrated

Superfamily **CRYPTODIFFLUGIACEA** Jung, 1942

Pseudopodia pointed or bifurcating, anastomosing.

Family **CRYPTODIFFLUGIIDAE** Jung, 1942. Shell ovoid; composed of proteinaceous-material sometimes with an inner calcareous lining; aperture terminal or sub-terminal, circular.

Genus *Cryptodifflugia* Penard, 1890. Shell colourless, yellow or brown; ovoid; composed of an outer proteinaceous material usually lined with an inner calcareous layer; aperture terminal, circular. . . . p. 166

Genus *Difflugiella* Cash, 1904. Shell colourless; ovoid; composed of proteinaceous material; aperture terminal, circular. . . . not illustrated

Genus *Wailesella* Deflandre, 1928. Shell colourless; ovoid; composed of proteinaceous material; aperture sub-terminal, circular. . . . not illustrated

Family **PHRYGANELIDAE** Jung, 1942. Shell hemispherical or ovoid; composed of agglutinated mineral particles; aperture terminal, circular.

Genus *Phryganella* Penard, 1902. Shell colourless, yellow or brown; hemispherical or ovoid; composed of agglutinated mineral particles; aperture terminal, circular. . . . p. 168

Class **FILOSIA** Leidy, 1879

Pseudopodia filiform, tapering, branching and anastomosing.

Order **GROMIDA** Claparède and Lachmann, 1859

With a shell or lorica having a distinct aperture for extrusion of filose pseudopodia.

Superfamily **GROMIACEA** Reuss, 1862

Family **GROMIIDAE** Reuss, 1862. Shell proteinaceous, rigid or slightly flexible, sometimes with agglutinated particles; single aperture.

Genus *Pseudodifflugia* Schlumberger, 1845. Shell ovoid or globular, rigid, composed of proteinaceous material with agglutinated particles; aperture terminal, usually large and circular. . . . p. 172

Family **AMPHITREMATIDAE** Poche, 1913. Shell ovoid or elongate; composed of proteinaceous material sometimes with agglutinated particles; apertures at both poles of shell.

Genus *Amphitrema* Archer, 1867. Shell colourless, yellow or brown; ovoid or elongate; composed of proteinaceous material sometimes with added mineral particles; aperture at each pole, oval, often with an external collar. . . . not illustrated

Superfamily **EUGLYPHACEA** Wallich, 1864

Shell composed of variously shaped siliceous shell-plates.

Family **EUGLYPHIDAE** Wallich, 1864. Shell ovoid or circular; composed of regularly arranged siliceous shell-plates, siliceous spines sometimes present; aperture terminal, circular, oval or lenticular, surrounded by either denticulate apertural-plates or an organic border.

Genus *Euglypha* Dujardin, 1840. Shell colourless; ovoid, oval or circular in transverse section; composed of oval or circular shell-plates, elongated shell-plates or siliceous spines, may be present; aperture circular or oval, bordered by regularly arranged denticulate apertural-plates. . . . p. 176

Genus *Assulina* Ehrenberg, 1872. Shell brown or colourless; ovoid, oval in transverse section; composed of oval shell-plates; aperture oval or lenticular, bordered by organic cement. . . . p. 192

Genus *Placocista* Leidy, 1879. Shell colourless; ovoid, oval in transverse section; composed of oval shell-plates, siliceous spines sometimes present at lateral margins; aperture lenticular, bordered by organic cement. . . . p. 198

Genus *Sphenoderia* Schlumberger, 1854. Shell colourless; ovoid or circular, oval or circular in transverse section; composed of oval or circular shell-plates; aperture lenticular with a small collar composed of smaller oval shell-plates. . . . p. 200

Genus *Tracheleuglypha* Deflandre, 1928. Shell colourless; ovoid, circular in transverse section; composed of circular shell-plates; aperture circular, bordered by organic cement. . . . p. 202

Family **TRINEMATIIDAE** Hoogenraad and de Groot, 1940. Shell ovoid with apertural region laterally compressed; composed of oval or circular siliceous shell-plates; aperture sub-terminal, circular or ovoid, invaginated and bordered by small denticulate apertural-plates.

Genus *Trinema* Dujardin, 1841. Shell colourless; ovoid, oval or circular in transverse section; composed of large circular and small oval shell-plates; aperture circular, invaginated and bordered by small, denticulate apertural-plates. . . . p. 204

Genus *Corythion* Taranek, 1881. Shell colourless; ovoid, oval in transverse section; composed of small oval shell-plates; aperture oval, invaginated and bordered by small denticulate, apertural-plates.

. . . p. 208

Family **CYPHODERIIDAE** de Saedeleer, 1934. Shell retort-shaped; composed of regularly arranged circular shell-plates, aperture terminal, circular, sometimes with disc-shaped collar.

Genus *Cyphoderia* Schlumberger, 1845. Shell colourless or yellow; retort-shaped and circular in transverse section; composed of circular shell-plates; aperture terminal, circular. . . . p. 210

Genus *Campascus* Leidy, 1877. Shell colourless or yellow; retort-shaped and oval in transverse section; composed of circular siliceous shell-plates; aperture terminal, circular bordered by a thin, transparent disc-like collar. . . . not illustrated

Family **PAULINELLIDAE** de Saedeleer, 1934. Shell ovoid; composed of elongate siliceous shell-plates regularly arranged in transverse rows; aperture terminal, oval.

Genus *Paulinella* Lauterborn, 1895. Shell colourless or yellow; ovoid and circular in transverse section; composed of elongate, curved siliceous shell-plates, aperture terminal, oval with a small neck.

. . . not illustrated

List of Species Recorded in Britain

ARCELLIDAE

Arcella arenaria Greeff, 1866
artocrea Leidy, 1876
bathystoma Deflandre, 1928
catinus Penard, 1890
conica Playfair, 1918
costata Ehrenberg, 1847
crenulata Deflandre, 1928
dentata Ehrenberg, 1832
discoides Ehrenberg, 1843
gibbosa Penard, 1890
hemisphaerica Perty, 1852
mitrata Leidy, 1876
polypora Penard, 1890
vulgaris Ehrenberg, 1830

CENTROPYXIDAE

Centropyxis aculeata (Ehrenberg, 1830)
aerophila Deflandre, 1929
cassis (Wallich, 1864)
constricta (Ehrenberg, 1841)
discoides Penard, 1890
ecornis (Ehrenberg, 1841)
hirsuta Deflandre, 1929
laevigata Penard, 1890
orbicularis Deflandre, 1929
platystoma Penard, 1890
spinosa Cash, 1905

PLAGIOPYXIDAE

Plagiopyxis callida Penard, 1910

Bullinularia indica (Penard, 1907)

TRIGONOPYXIDAE

Trigonopyxis arcula (Leidy, 1879)

Cyclopyxis arcelloides (Leidy, 1879)
eurystoma (Deflandre, 1929)
kahli (Deflandre, 1929)

HYALOSPHENIIDAE

Hyalosphenia cuneata Stein, 1857
elegans Leidy, 1874
inconspicua West, 1903
minuta Cash, 1892
ovalis Wailes, 1912
papilio Leidy, 1875
platystoma West, 1903
subflava Cash & Hopkinson, 1909

Heleopera lata Cash, 1909
petricola Leidy, 1879
rosea Penard, 1890
sordida Penard, 1910
sphangi (Leidy, 1874)
sylvatica Penard, 1890

Lesquereusia epistomium Penard, 1902
inaequalis Cash, 1909
modesta Rhumbler, 1895
spiralis (Ehrenberg, 1840)

Nebela acolla Cash, 1909
barbata Leidy, 1874
bigibbosa Penard, 1890
bipes (Carter, 1870)
carinata (Archer, 1867)
caudata Leidy, 1876
collaris (Ehrenberg, 1848)
dentistoma Penard, 1890
equicalceus Leidy, 1874
flabellulum Leidy, 1874
galeata Penard, 1890
griseola Penard, 1911
lageniformis Penard, 1890
marginata Penard, 1902
militaris Penard, 1890
minor Penard, 1902
parvula Cash, 1909
penardiana Deflandre, 1936
scotia Brown, 1911
tenella Penard, 1893
tincta (Leidy, 1879)
triangulata (Lang, 1865)
tubulata Brown, 1911

tubulosa Penard, 1890
vitraea Penard, 1899

Quadrulella symmetrica (Wallich, 1863)

Leptochlamys ampullacea West, 1901

PARAQUADRULIDAE

Paraquadrula irregularis (Archer, 1877)

DIFFLUGIIDAE

Difflugia acuminata Ehrenberg, 1838
amphoralis Hopkison, 1909
avellana Penard, 1890
bacillariarum Perty, 1849
bacillifera Penard, 1890
brevicola Cash, 1909
claviformis Penard, 1899
corona Wallich, 1864
curvicaulis Penard, 1899
elegans Penard, 1890
globulosa Dujardin, 1837
gramen Penard, 1902
labiosa Wailes, 1919
lanceolata Penard, 1890
lithophila Penard, 1902
lobostoma Leidy, 1874
longicollis Gassowsky, 1936
lucida Penard, 1890
manicata Penard, 1902
oblonga Ehrenberg, 1838
olliformis Lagerhiem, 1901
orbicularis Cash, 1909
oviformis Cash, 1909
penardi Hopkinson, 1909
petricola Cash, 1909
pristis Penard, 1902
pulex Penard, 1902
rubescens Penard, 1891
tuberculata (Wallich, 1864)
urceolata Carter, 1864
viscidula Penard, 1902

Pontigulasia bryophila Penard, 1902
compressa (Carter, 1864)
elisa (Penard, 1893)
rhumbleri Hopkinson, 1919
vas (Leidy, 1874)

Cucurbitella mespiliformis Penard, 1901

CRYPTODIFFLUGIIDAE

Difflugiella apiculata Cash, 1904

Cryptodifflugia compressa Penard, 1902
oviformis Penard, 1890
sacculus Penard, 1902

Wailesella eboracensis (Wailes, 1911)

PHRYGANELLIDAE

Phryganella acropodia (Hertwig & Lesser, 1874)
nidulus Penard, 1902
paradoxa Penard, 1902

GROMIIDAE

Pseudodifflugia fulva (Archer, 1870)
gracilis Schlumberger, 1845

AMPHITREMIDAE

Amphitrema flavum (Archer, 1877)
stenostoma Nuesslin, 1884
wrightianum Archer, 1869

EUGLYPHIDAE

Euglypha acanthophora (Ehrenberg, 1841)
brachiata Leidy, 1878
bryophila Brown, 1911
ciliata (Ehrenberg, 1848)
compressa Carter, 1864
cristata Leidy, 1874
denticulata Brown, 1912
filifera Penard, 1890
laevis (Ehrenberg, 1845)
mucronata Leidy, 1878
rotunda Wailes, 1911
scutigera Penard, 1911
strigosa (Ehrenberg, 1872)
tuberculata Dujardin, 1841

Assulina muscorum Greeff, 1888
scandinavica Penard, 1890
seminulum (Ehrenberg, 1848)

Placocista jurassica Penard, 1905
lens (Penard, 1899)
spinosa (Carter, 1865)

Sphenoderia fissirostris Penard, 1890
lenta Schlumberger, 1845
macrolepis Leidy, 1879

Tracheleuglypha dentata (Moniez, 1888)

TRINEMATIIDAE

Trinema complanatum Penard, 1890
enchelys (Ehrenberg, 1838)
lineare Penard, 1890

Croythion dubium Taranek, 1881
pulchellum Penard, 1890

CYPHODERIIDAE

Cyphoderia ampulla (Ehrenberg, 1840)
trochus Penard, 1899

Campascus minutus Penard, 1899

PAULINELLIDAE

Paulinella chromatophora Lauterborn, 1895

Descriptions and Illustrations

Species described in this book have been reported from one or more of the following habitats: acidic permeable, alpine, grass and forest soils; forest litters; lichens and damp mosses in woods or on rocks; detritus rich fens; peat and swamp bogs; damp and submerged mosses, particularly *Sphagnum* moss; the ooze or sediment of ditches and ponds; running and standing water, shallow lakes and occasionally in deep water lakes; and activated sludge from sewage treatment works.

The measurements included with the descriptions are in microns (μm) and the number of specimens examined is designated by the figure after the prefix n. Each measurement has been taken at the same position, as near as possible, in each specimen. The length of the specimen is given to include aboral protruberances and spines when they are part of the shell matrix (e.g. *Centropyxis* and *Difflugia*), but excluded when they are specialised shell components (e.g. *Euglypha* and *Placocista*); the breadth is taken at the widest point, and the aperture is taken as the greatest internal diameter.

Arcella arenaria Greeff, 1866

DESCRIPTION The shell is brown, circular and has a conical aboral region. The apertural surface is usually smooth (Figs. A and B) but often has small pores towards the basal collar. The aboral region is smooth and appears to be divided into segments. These divisions are formed by folds on the shell surface that run from the flat crown to the basal collar (Figs. C and D). The aperture is invaginated, circular, bordered by a lip and about twenty large pores (Figs. A and E). The pores are often seen to be blocked (Fig. E), and this may account for the difference in numbers between our observations and previous workers.

A variety, *A. a.* var. *sphagnicola*, was suggested by Deflandre (1928*a*) for larger specimens having reduced shell folding and no apertural pores. Our observations suggest that this is probably a doubtful variety.

This species is similar to *Arcella catinus*, but can be distinguished using the size of the aperture or the ratio Da/Ds (Diameter of aperture ÷ Diameter of shell), and the number of apertural pores.

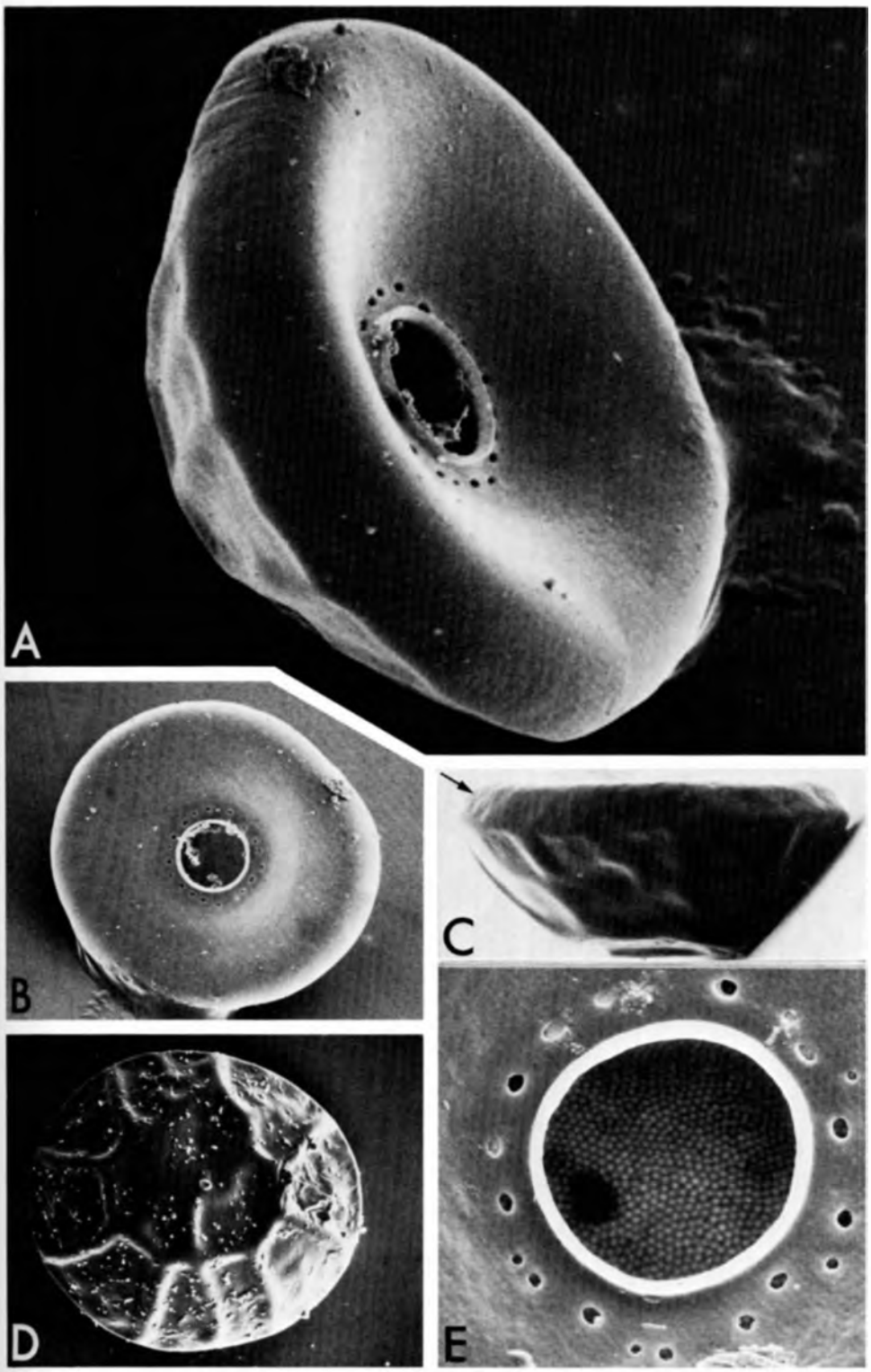
MEASUREMENTS (in μm)

Author	Diameter of shell (Ds)	Depth	Diameter of aperture (Da)	Da/Ds	Number of apertural pores
Cash *et al.*, 1919	60–80				
Deflandre, 1928	79–91	25–38	14–18		8–12
present work n = 15	79–130	21–50	22–28	0.18–0.22	18–24

GEOGRAPHICAL DISTRIBUTION Belgium, British Isles, Bulgaria, Canada, Czechoslovakia, France, Gabon, Germany, Greece, Hungary, Iceland, Netherlands, Poland, Roumania, Spain, Spitzbergen, Sweden.

REFERENCES Bonnet, 1967*a*, 1967*b*; Bonnet & Thomas, 1960; Chardez, 1966; Deflandre, 1928*a*; Decloitre, 1965; Godenau *et al.*, 1973; Golemansky, 1973, 1974*b*; Graaf, 1956; Gracia, 1972; Laminger, 1972*a*, 1972*c*; Puytorac *et al.*, 1972; Schönborn, 1975.

Fig. A View showing invaginated aperture × 1000
Fig. B Apertural view × 370
Fig. C Lateral view, to show basal collar (arrowed) × 490
Fig. D Aboral view, the surface is covered with extraneous debris × 350
Fig. E Aperture, showing pores that have been blocked × 1630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Arcella artocrea Leidy, 1876

DESCRIPTION The shell is brown, circular and has a conical aboral region which is often covered by dents or depressions (Figs. A and B). The basal collar is usually prominent and smooth (Fig. B). The aperture is invaginated, circular, has a small lip and is surrounded by about thirty large and some small pores (Fig. C). The specimen illustrated is probably an encysted form, as the aperture is closed by a cyst plug (Figs. C and D).

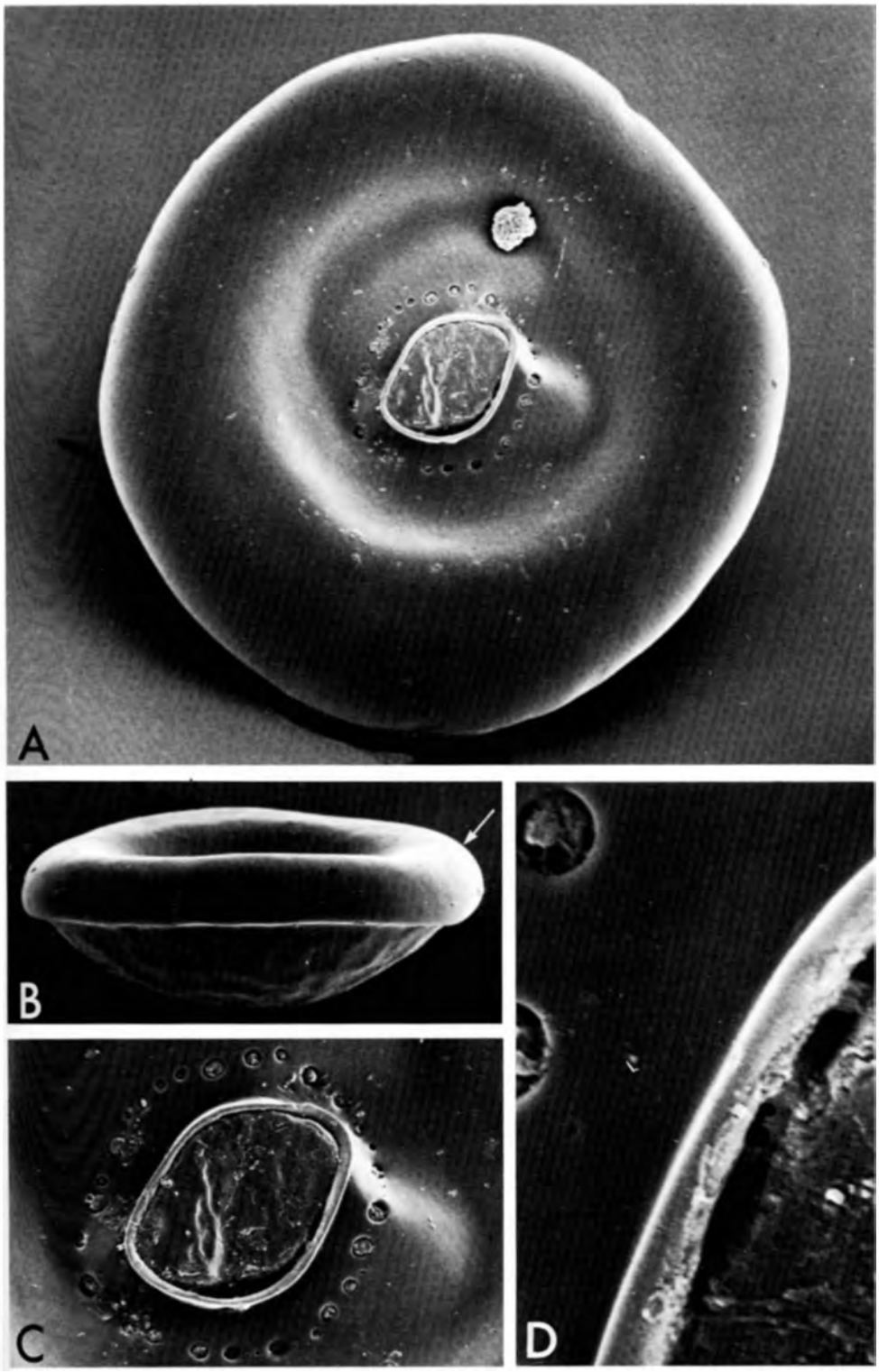
MEASUREMENTS (in μm)

Author	Diameter of shell	Depth of shell	Diameter of aperture
Leidy, 1876	184–216	46–64	36–42
present work n = 1	190	57	36

GEOGRAPHICAL DISTRIBUTION Austria, Belgium, British Isles, Canada, Congo, Germany, Iceland, Java, New Zealand, Roumania, Spitzbergen, Sumatra, United States of America.

REFERENCES Chardez, 1961*a*; Decloitre, 1965; Deflandre, 1928*a*; Godenau *et al.*, 1973; Hoogenraad & Groot, 1940*a*, 1948; Jung, 1936*a*; Laminger, 1972*c*, 1975; Steinecke, 1914; Štěpánek, 1963.

Fig. A Apertural view × 540
Fig. B Lateral view to show basal collar (arrowed) × 360
Fig. C Aperture, illustrating the arrangement of the pores × 880
Fig. D Portion of apertural lip showing the organic cement holding the cyst plug × 5000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Arcella bathystoma Deflandre, 1928

DESCRIPTION The shell is brown, circular with a domed aboral region having several angular facets (Figs. A and E). The shell surface appears to be either smooth or pitted with numerous small pores (Fig. C). The aperture is invaginated, circular (Figs. A and B), and surrounded by a small lip (Fig. D).

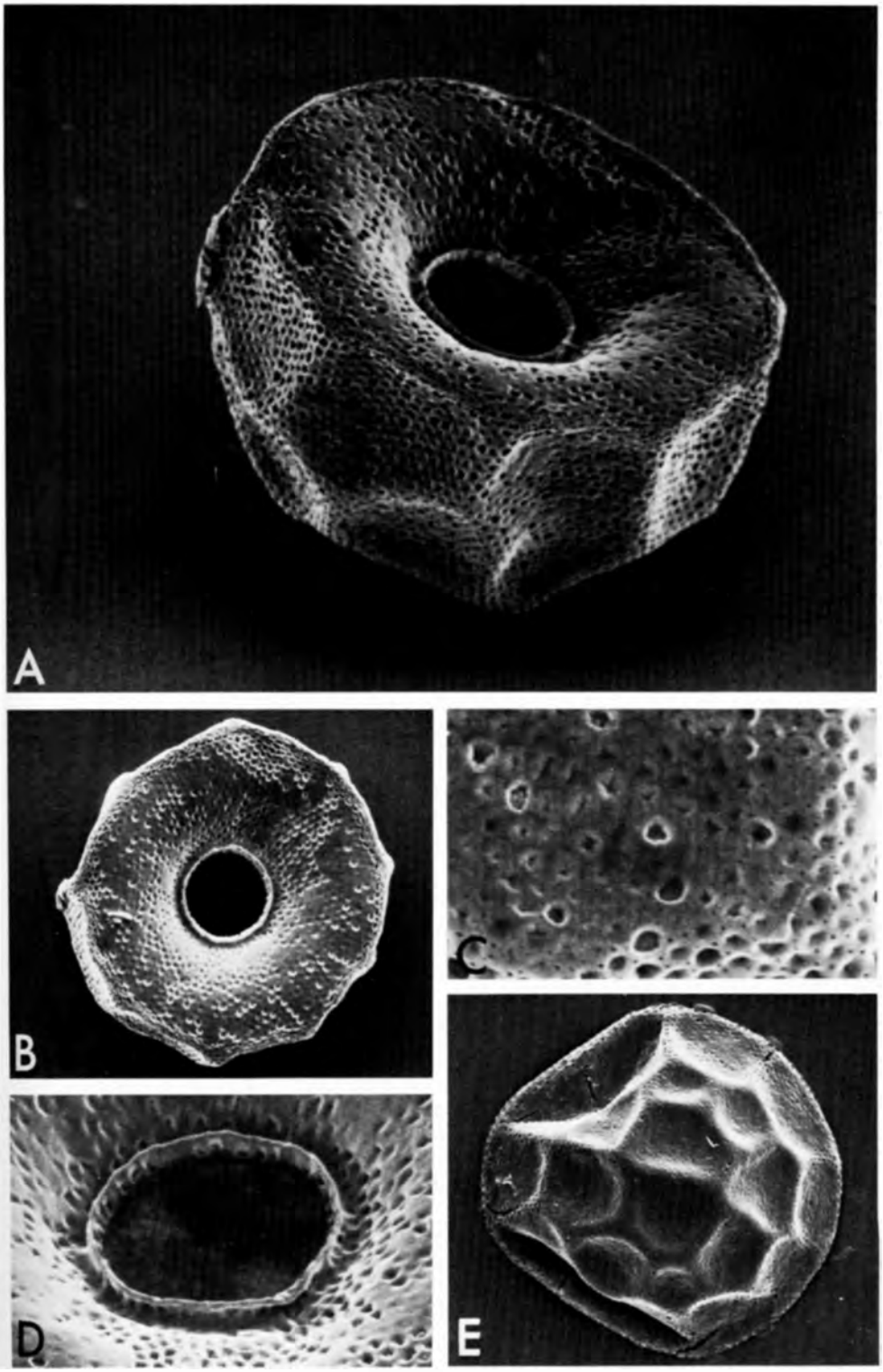
MEASUREMENTS (in μm)

Author	Diameter of shell	Depth	Diameter of aperture
Deflandre, 1928	55–62	20–25	19–21
present work n = 2	49–53	28–32	13–15

GEOGRAPHICAL DISTRIBUTION British Isles, France, Germany, Roumania.

REFERENCES Deflandre, 1928a; Grospietch, 1958*a*; Godenau *et al.*, 1973.

Fig. A Latero-apertural view × 1580
Fig. B Apertural view × 820
Fig. C Shell surface showing pitting and small pores × 4000
Fig. D Lateral view of aperture × 2700
Fig. E Aboral view, showing angular facets × 680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Arcella catinus Penard, 1890

DESCRIPTION The shell is brown, usually circular and has a shallow conical aboral region. The apertural surface is usually smooth but often has small pores around the basal collar (Fig. A). The aboral region is smooth and is divided into segments by folding of the shell surface (Figs. B and C). The aperture is invaginated, circular, has a small lip and is surrounded by as many as fifty large and small pores (Fig. D).

The similarity between *A. catinus* and *A. arenaria* has led to some confusion in earlier descriptions. It would appear from the present work that these two species may be distinguished by the size of the aperture and the number of pores surrounding it.

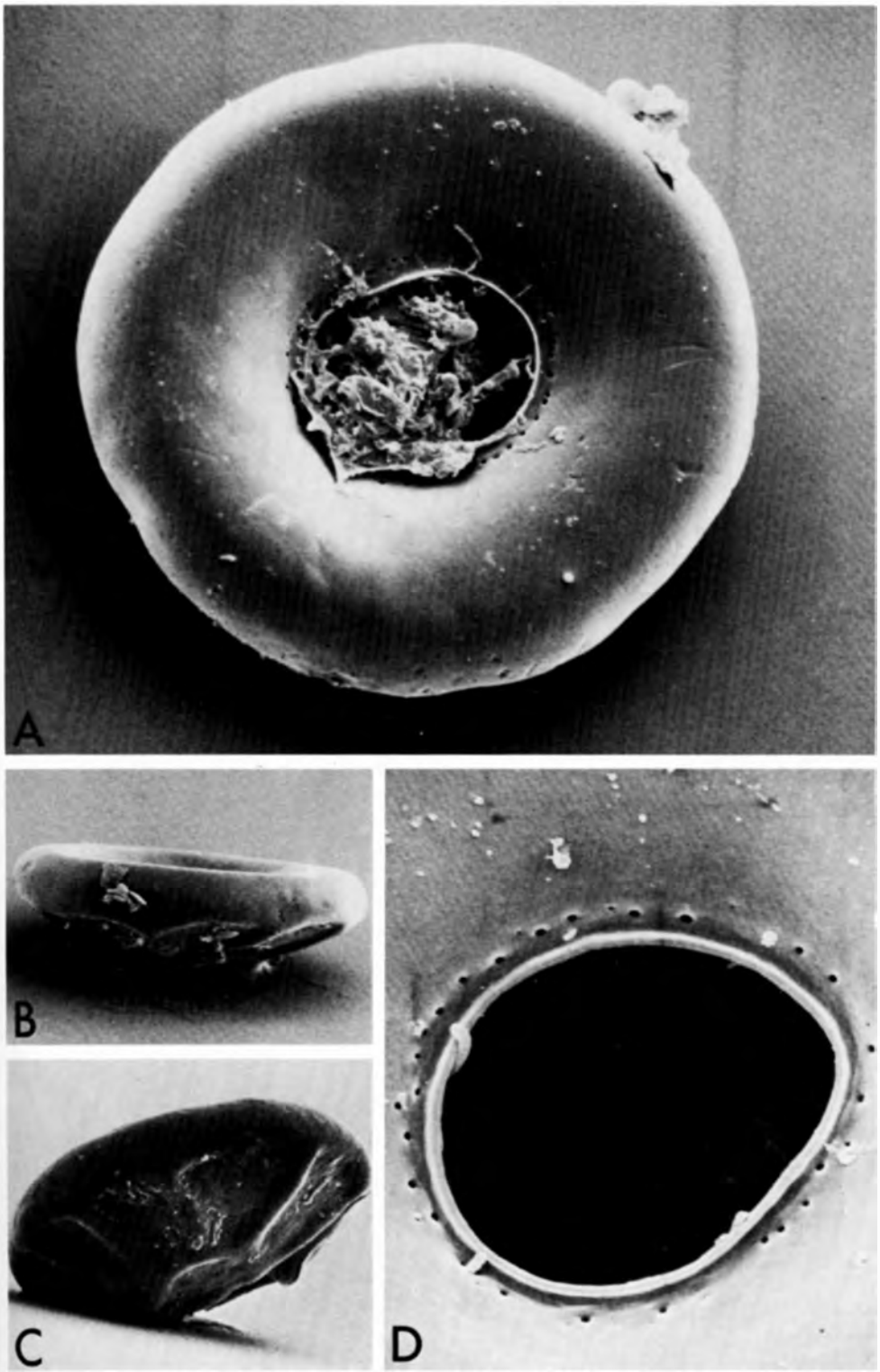
MEASUREMENTS (in μm)

Author	Diameter of shell (Ds)	Depth	Diameter of aperture (Da)	Da/Ds	Number of apertural pores
Cash *et al.*, 1905 and 1919	100–200	45			
Deflandre, 1928	77–116	32–46	18–26		12–26
present work n=6	73–114	22–29	22–37	0.30–0.33	35–50

GEOGRAPHICAL DISTRIBUTION Austria, Australia, Belgium, British Isles, Bulgaria, Canada, Congo, Costa Rica, Czechoslovakia, France, Finland, Germany, Greenland, Hungary, Iceland, Java, Luxembourg, Netherlands, Norway, Marion I., Poland, Roumania, Russia, Spain, Sweden, Switzerland, United States of America, West Africa.

REFERENCES Chardez, 1961*a*; Decloître, 1948, 1949, 1954, 1965; Deflandre, 1928*a*; Godenau *et al.*, 1973; Golemansky, 1974*b*; Graaf, 1956; Grospietch, 1958*a*, 1971; Hoogenraad & Groot, 1946; Jung, 1936*a*; Laminger, 1973*b*, 1975; Lousier, 1976; Playfair, 1918; Štěpánek, 1963.

Fig. A Apertural view, part of aperture obscured by extraneous debris × 1020
Fig. B Lateral view showing basal collar × 550
Fig. C Aboral view × 600
Fig. D Aperture, showing large and small pores × 2170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Arcella conica Playfair, 1918

DESCRIPTION The shell is brown, circular with a domed aboral region. The domed region is depressed to form angular facets which are bordered by prominent folds (Figs. A and C). The shell surface appears to be irregular and has numerous small pores. The aperture is slightly invaginated, circular and bordered by a collar (Figs. B and C).

Variation in this species appears to be restricted to the arrangement of the angular folds.

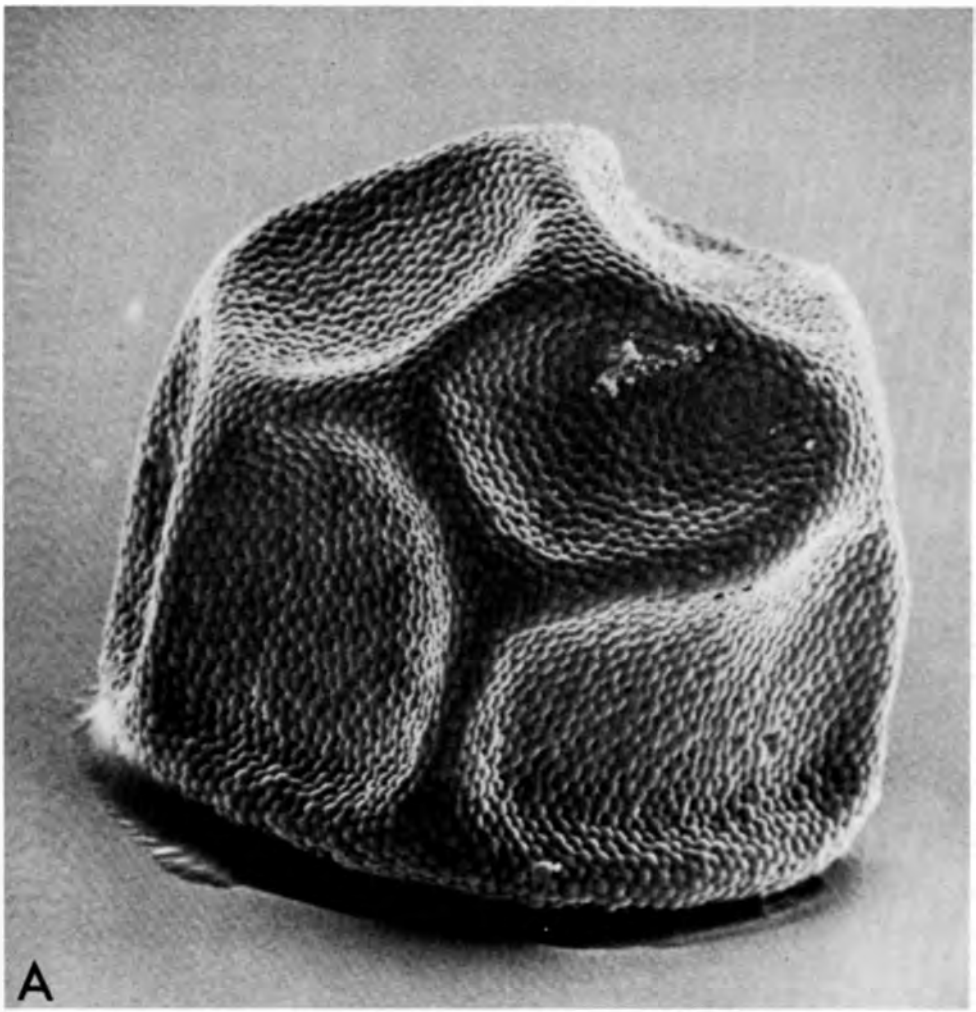
MEASUREMENTS (in μm)

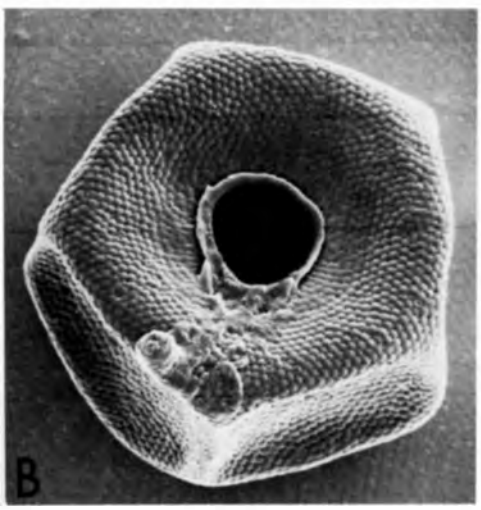
Author	Diameter of shell	Depth	Diameter of aperture
Playfair, 1918	50–80	31–48	13–20
Deflandre, 1928	69–80	31–48	20–22
present work n = 3	68–76	63–66	23–33

GEOGRAPHICAL DISTRIBUTION Argentina, Australia, Belgium, Brazil, British Isles, Canada, Congo, France, Germany, Roumania, South Africa, United States of America, Venezuela, West Africa.

REFERENCES Chardez, 1961*a*; Decloitre, 1947, 1948, 1949, 1954; Deflandre, 1926, 1928*a*; Godenau *et al.*, 1973; Green, 1975; Grospietch, 1958*b*; Laminger, 1972*a*; Playfair, 1918; Štěpánek, 1963; Vucetich, 1972.

Fig. A Lateral view showing angular facets × 1310
Fig. B Apertural view × 640
Fig. C Latero-apertural view × 610


A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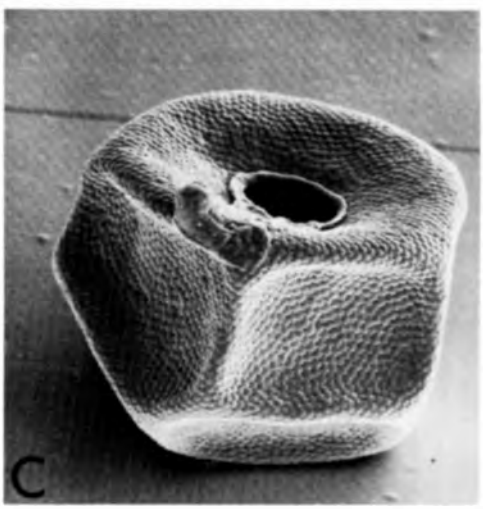

C

Arcella crenulata Deflandre, 1928

DESCRIPTION The shell is brown, circular with a domed aboral region (Figs. A and B). In lateral aspect there usually appears to be a basal collar at the border of the shell (Fig. B). The shell surface is smooth or irregular and has numerous small pores (Fig. D). The aperture is invaginated, circular and has a denticular margin (Fig. C).

This species was initially described by Deflandre (1928*a*) as a variety of *Arcella vulgaris*. We consider that the difference in the shape of the aperture is sufficient to treat *A. crenulata* as a valid species.

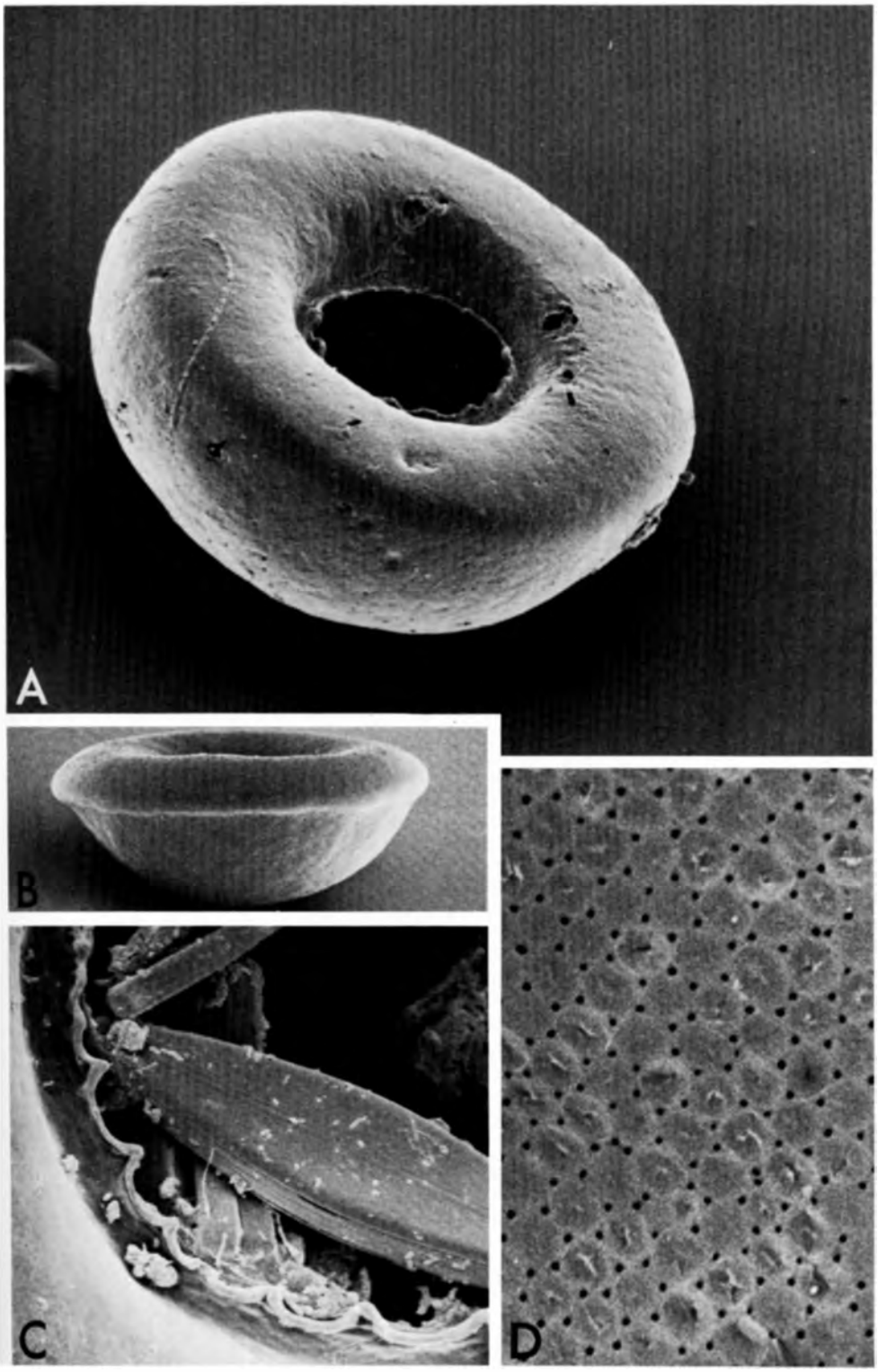
MEASUREMENTS (in μm)

Author	Diameter of shell	Depth	Diameter of aperture
Deflandre, 1928	120	63	40
present work n=7	113–160	52–58	24–53

GEOGRAPHICAL DISTRIBUTION British Isles, Brazil, Canada, Congo, Netherlands, United States of America.

REFERENCES Deflandre, 1928a; Graaf, 1956; Green, 1975; Štěpánek, 1963.

Fig. A Lateral view of aperture × 720
Fig. B Lateral view showing the basal collar × 350
Fig. C Part of aperture to show denticular margin. Diatoms and debris are inside the aperture × 1600
Fig. D Shell surface with small pores × 4600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Arcella discoides Ehrenberg, 1843

DESCRIPTION The shell is yellow or brown, circular (Fig. A), and has a shallow conical aboral region with a basal border or collar (Fig. D). The whole of the shell surface appears to have small pores, although they are less apparent on the basal collar (Fig. C). The aperture is invaginated, circular and bordered by a shallow lip (Fig. B).

Specimens of this species appear to be delicate and are often found damaged or torn.

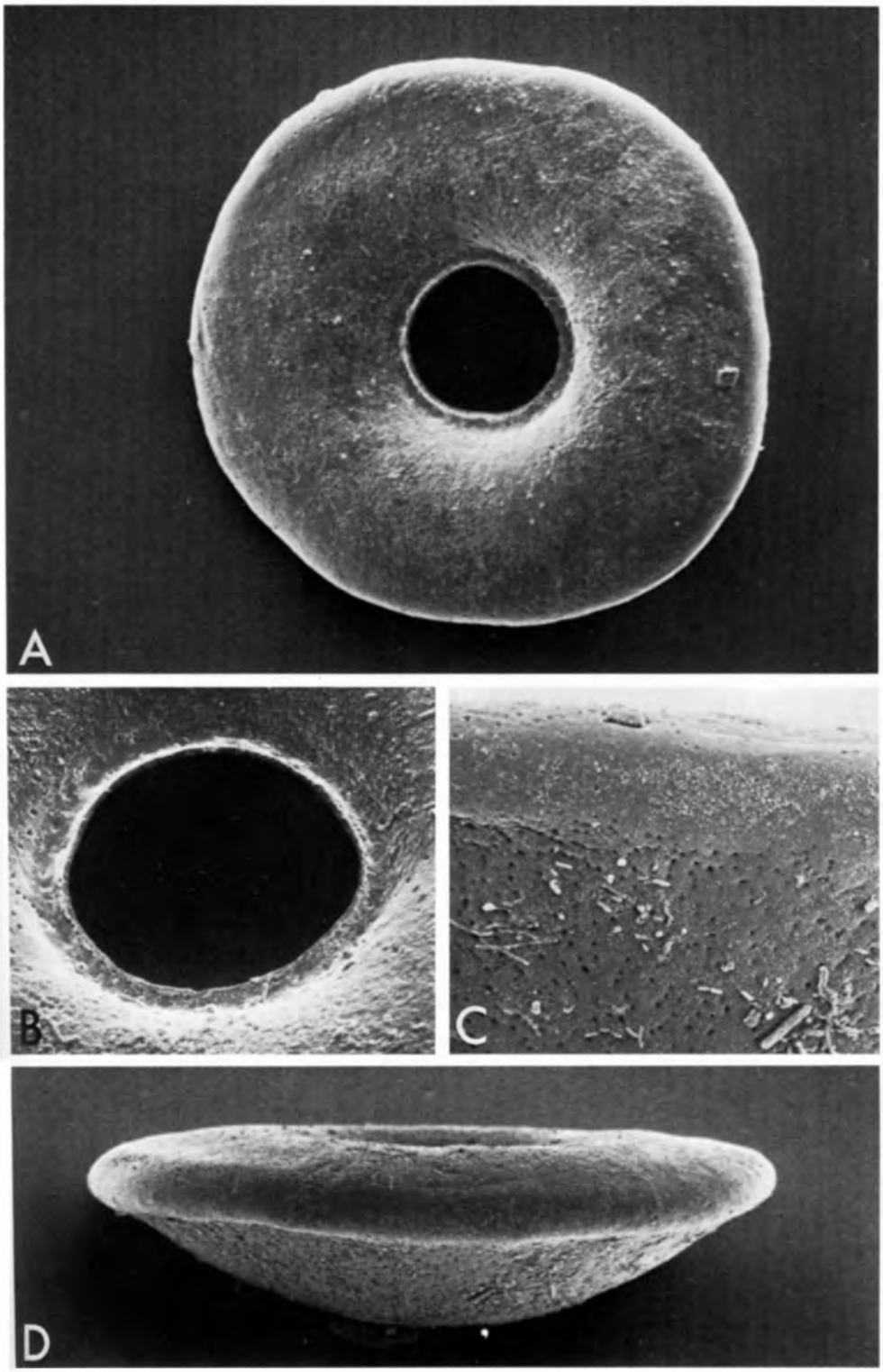
MEASUREMENTS (in μm)

Author	Diameter of Shell	Depth	Diameter of aperture
Deflandre, 1928	124	29	48
present work n = 9	83–104	23–30	21–31

GEOGRAPHICAL DISTRIBUTION Argentina, Austria, Belgium, Brazil, British Isles, Bulgaria, Canada, Congo, Costa Rica, France, Germany, Hungary, Iceland, Italy, Mexico, Poland, Roumania, Russia, Senegal, Switzerland, United States of America.

REFERENCES Boltovskoy & Lena, 1974; Chardez, 1961*a*; Chibisova, 1967; Decloitre, 1948, 1951, 1965; Deflandre, 1928*a*; Gal, 1969; Godenau *et al.*, 1973; Golemansky, 1970, 1973, 1974*b*; Green, 1975; Jung, 1936*a*; Laminger, 1973*b*, 1975; Lousier, 1976; Rampi, 1947; Steinecke, 1914; Štěpánek, 1963; Vucetich, 1972.

Fig. A Apertural view × 850
Fig. B Close up of aperture showing the shallow lip × 1360
Fig. C View of basal collar to show distribution of small surface pores × 1640
Fig. D Lateral view × 890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Arcella gibbosa Penard, 1890

DESCRIPTION The shell is yellow or brown, circular and is domed or hemispherical in lateral view. The apertural surface and the basal collar are smooth (Figs. A and B), but the aboral hemisphere has a series of regular depressions (Fig. D). The shell surface may be smooth or irregular and has numerous small pores (Fig. C). The aperture is invaginated, circular and has a distinct rim or lip (Figs. A and B).

Variation appears to be restricted to the number or absence of depressions on the domed aboral region (Deflandre, 1928*a*).

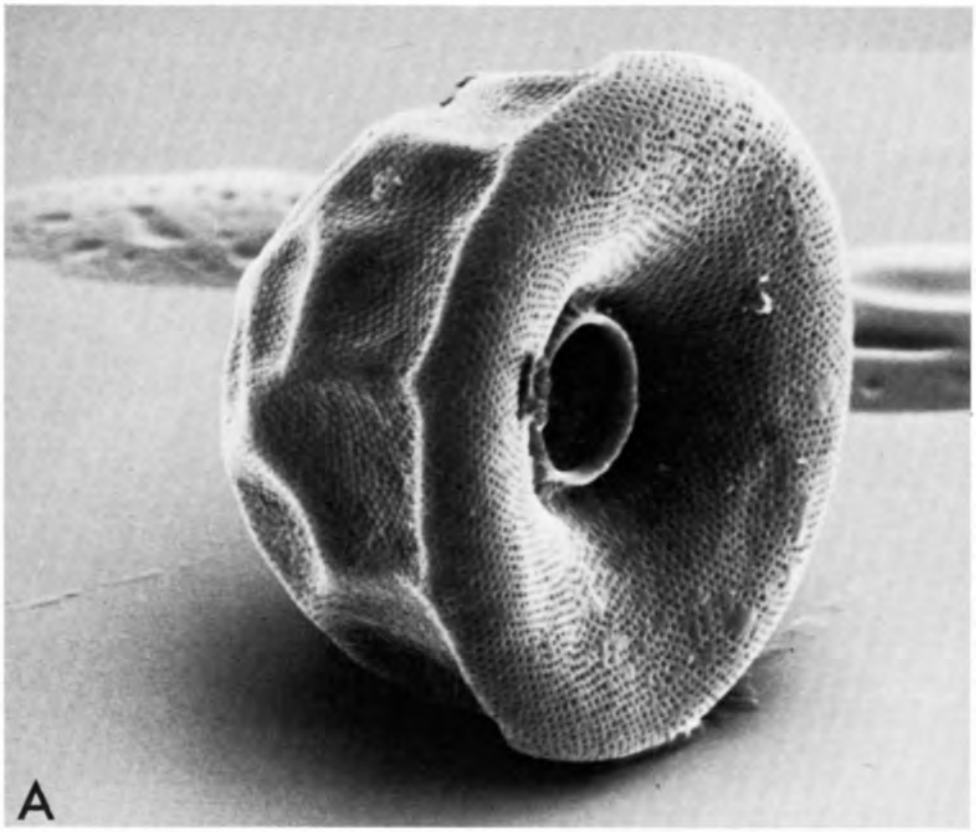
MEASUREMENTS (in μm)

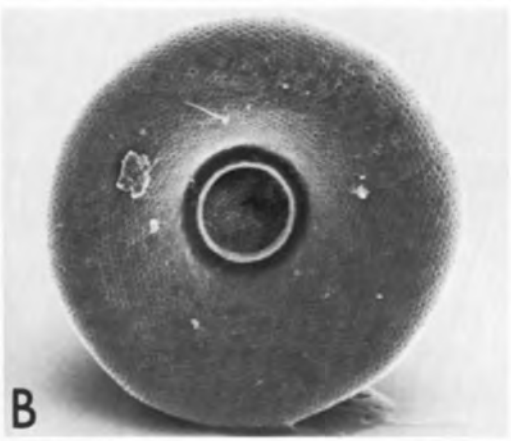
Author	Diameter of shell	Depth	Diameter of aperture
Deflandre, 1928	70–125	49–74	21–32
present work n = 1	90	61	19

GEOGRAPHICAL DISTRIBUTION Austria, Belgium, British Isles, Brazil, Canada, Congo, Czechoslovakia, Finland, France, Germany, Netherlands, Roumania, Sweden, Switzerland, West Africa.

REFERENCES Chardez, 1961*a*; Decloitre, 1947, 1948, 1949, 1954; Deflandre, 1928*a*; Godenau *et al.*, 1973; Graaf, 1956; Green, 1975; Grospietch, 1958*a*; Laminger, 1972*c*; Puytorac *et al.*, 1972; Schönborn, 1975; Štěpánek, 1963, 1967.

Fig. A View showing the invaginated aperture and apertural collar × 890
Fig. B Apertural view × 530
Fig. C Portion of basal collar showing the small pores on the shell surface × 2100
Fig D Lateral view × 600


A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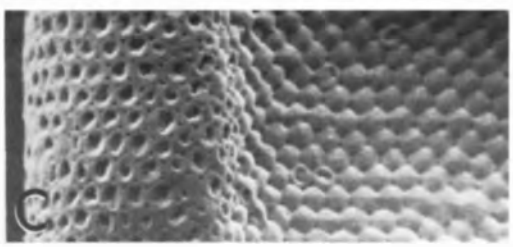

C


D

Arcella hemisphaerica Perty, 1852

DESCRIPTION The shell is yellow or brown, circular, and hemispherical in lateral view (Figs. A and B). The shell surface is either smooth or irregular and has small pores (Fig. C). The aperture is slightly invaginated, circular, and bordered by a lip (Fig. A).

This species was considered by Cash (1905) to be a synonym of *A. vulgaris* although Deflandre (1928*a*) and subsequent authors have regarded it as a distinct species. There appears to be some variation in the size and shape of the shell, and the degree of invagination of the aperture (Deflandre, 1928*a*).

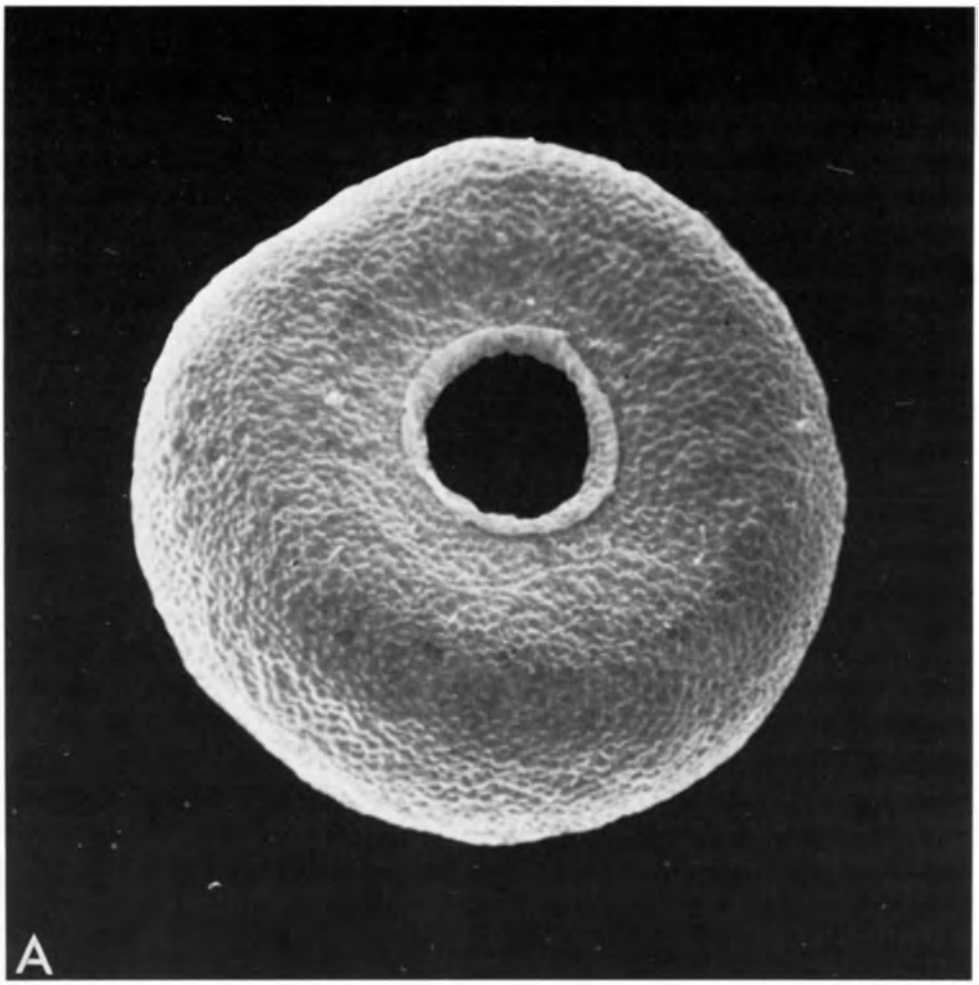
MEASUREMENTS (in μm)

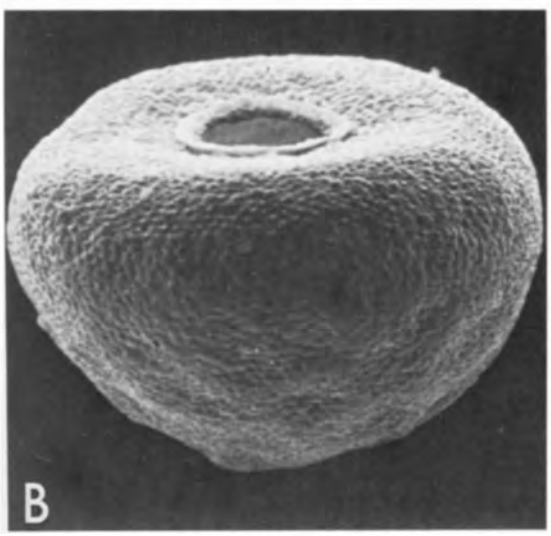
Author	Diameter of shell	Depth	Diameter of aperture
Deflandre, 1928	45–56	36–42	13–18
present work n = 7	55–63	23–35	11–14

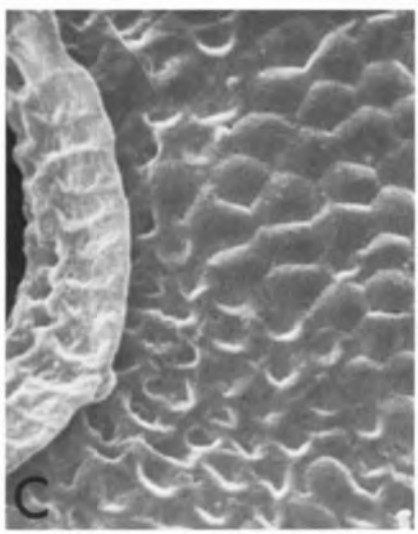
GEOGRAPHICAL DISTRIBUTION Annobón I., Argentina, Australia, Austria, Belgium, Brazil, British Isles, Canada, Chile, Congo, Costa Rica, Finland, France, Germany, Guatemala, Haiti, Hungary, Iceland, Netherlands, New Zealand, Poland, Roumania, Russia, Spain, Switzerland, United States of America, Venezuela, West Africa.

REFERENCES Chardez, 1956, 1961*a*; Decloitre, 1948, 1949, 1954, 1965; Deflandre, 1926, 1928*a*; Gal, 1969; Godenau *et al.*, 1973; Golemansky, 1970; Graaf, 1956; Gracia, 1963, 1972; Green, 1975; Grospietch, 1958*a*; Laminger, 1972*a*, 1972*c*, 1973*b*, 1975; Playfair, 1918; Štěpánek, 1963; Vucetich, 1972.

Fig. A Apertural view × 1330
Fig. B Lateral view × 1000
Fig. C Portion of shell near the apertural lip × 4400


A


B


C

Arcella polypora Penard, 1890

DESCRIPTION The shell is brown, circular and has a shallow conical aboral region (Figs. A and C). The apertural surface of the shell is usually smooth (Fig. A), but the remainder of the shell has numerous small pores (Fig. D). The aperture is slightly invaginated, circular, bordered by a small lip and about sixty large pores (Fig. B).

This species is similar in shape to *A. discoides* and *A. megastoma*, but it can be distinguished from them on shell size, apertural size and the distribution or absence of pores around the aperture.

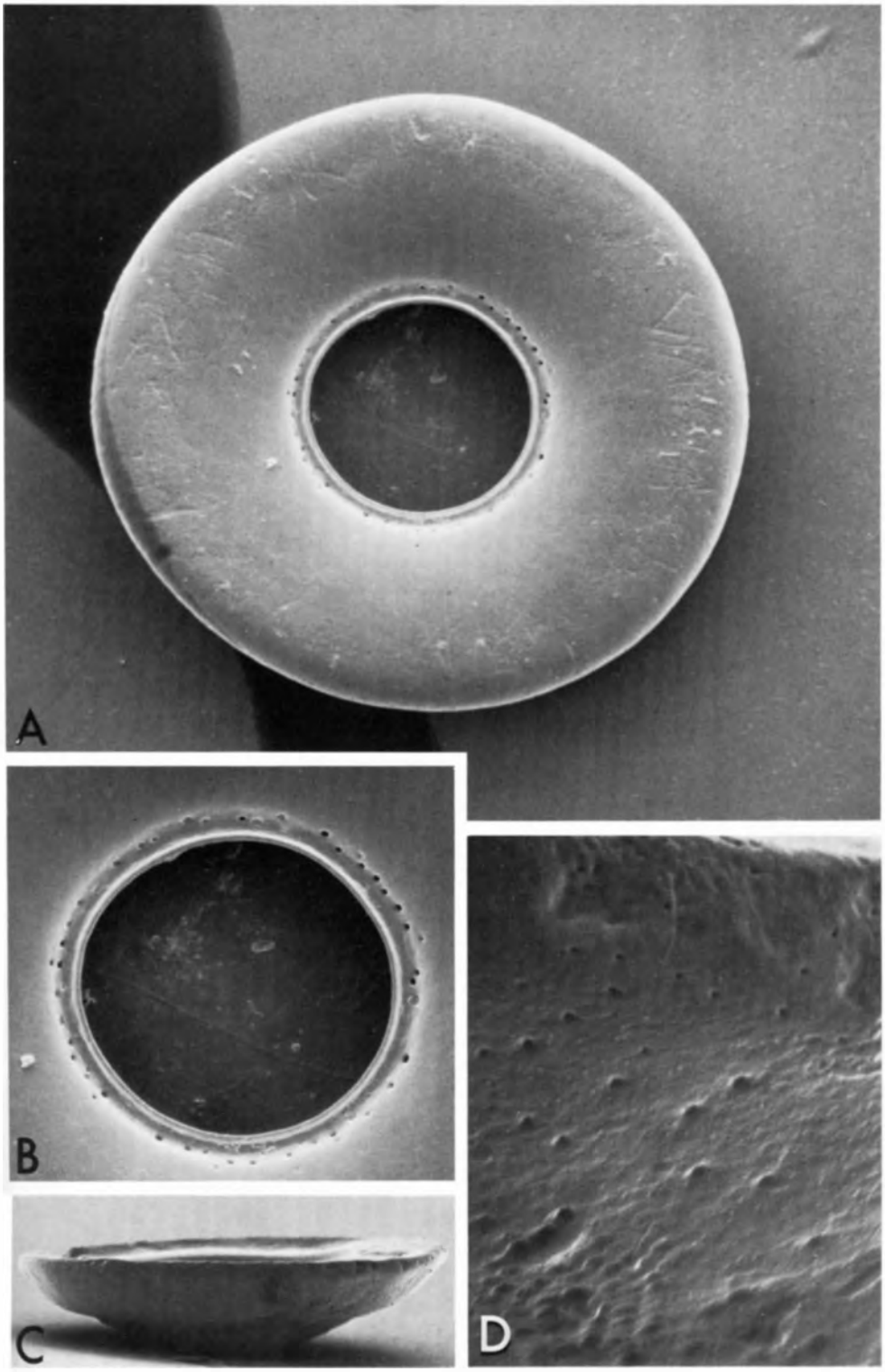
MEASUREMENTS (in μm)

Author	Diameter of shell	Depth	Diameter of aperture
Cash *et al.*, 1919	100–200		
Deflandre, 1928	120–125	25–36	37–43
present work n = 8	112–143	21–30	40–48

GEOGRAPHICAL DISTRIBUTION British Isles, Bulgaria, France, Germany, Iceland, Morocco, Netherlands, Roumania, Russia, South Africa, Switzerland, Venezuela, West Africa.

REFERENCES Decloitre, 1965; Deflandre, 1926, 1928*a*; Godenau *et al.*, 1973; Grospietch, 1958*b*.

Fig. A Apertural view × 660
Fig. B Aperture, to illustrate the surrounding large pores × 880
Fig. C Lateral view × 400
Fig. D Lateral view of portion of the shell × 1450


A
B
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D

Arcella vulgaris Ehrenberg, 1830

DESCRIPTION The shell is yellow or brown, circular (Fig. A) and is hemispherical in lateral view, often having a basal collar (Fig. B). The shell surface can be either smooth or irregular, and usually has numerous fine pores (Fig. C). The aperture is invaginated, circular, and bordered by a small lip (Fig. D).

The size of the hemisphere and the invagination of the aperture appear to be the usual variation seen in this species. Other differences in shell structure have resulted in several authors describing new forms or varieties, for example, Deflandre (1928*a*) lists eight in his review of the genus.

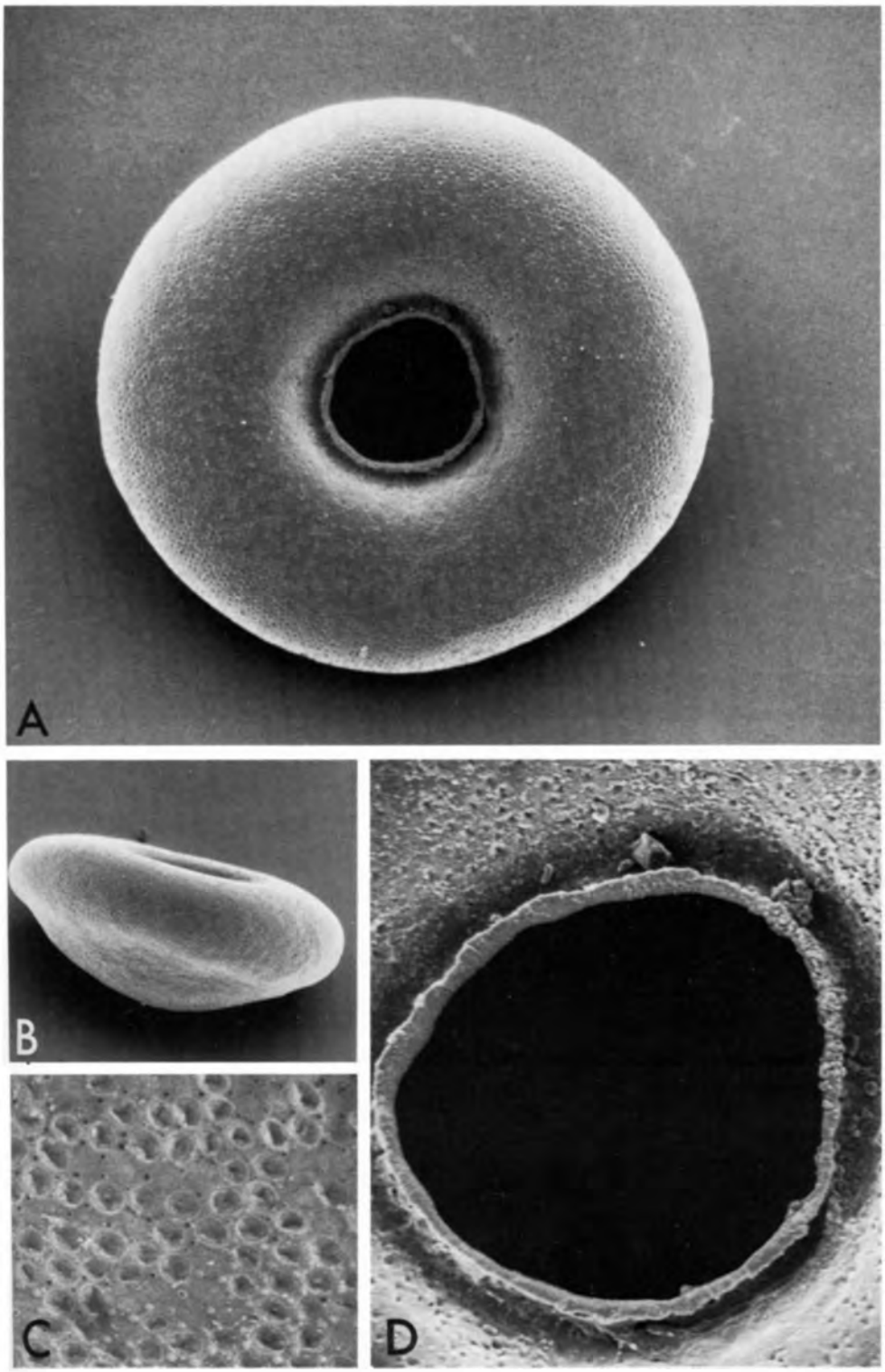
MEASUREMENTS (in μm)

Author	Diameter of shell	Depth	Diameter of aperture
Deflandre, 1928	100–145	52–73	30–47
present work n=4	104–136	46–56	22–32

GEOGRAPHICAL DISTRIBUTION Annobón I., Antarctica, Argentina, Australia, Austria, Belgium, Brazil, British Isles, Canada, Chile, China, Congo, Costa Rica, Faroes, France, Germany, Guatemala, Haiti, Hungary, Iceland, India, Italy, Japan, Java, Marion I., Mexico, Netherlands, Paraguay, Poland, Roumania, Russia, Signy I., South Africa, Spain, Spitzbergen, Sweden, Switzerland, Taihiti, United States of America, West Africa.

REFERENCES Bonnet, 1966; Chardez, 1961*a*; Decloitre, 1954, 1965; Deflandre, 1928*a*; Gal, 1969; Godeanu *et al.*, 1973; Golemansky, 1970; Gracia, 1963, 1972; Green, 1975; Grospietch, 1958*b*, 1971; Jung, 1936*a*; Laminger, 1972*c*, 1973*b*, 1975; Oye van, 1949; Rampi, 1947; Smith, 1973*a*; Steinecke, 1914; Štěpánek, 1963; Vucetich, 1972.

Fig. A Apertural view × 690
Fig. B Lateral view × 390
Fig. C Surface of shell showing collapsed alveoli and small pores × 3800
Fig. D Aperture, to illustrate the small lip × 1800


A
B
C
D

Centropyxis aculeata (Ehrenberg, 1830)

DESCRIPTION The shell is yellow or brown, ovoid or circular and usually has about four or more lateral spines (Fig. A). In lateral view it is spherical and tapers towards the aperture (Fig. B). The shell surface is rough, except for a smooth region around the aperture, and is often covered with sand grains or diatom frustules (Fig. D). Specimens cultured in the absence of extraneous particles produce a shell that is proteinaceous and similar in structure to species of *Arcella*. The aperture is invaginated, oval and sub-terminal (Figs. A and C).

Cash (1905) observed that specimens appear to differ widely from the type description and also from each other in size and structure. Deflandre (1929) in his review of the genus described three varieties of *C. aculeata* which differ in size, shape and the number of spines. In clonal culture both large and many spined specimens are produced, but these forms represent only a small percentage of the population.

MEASUREMENTS (in μm)

Author	Length of shell	Breadth of shell	Depth of shell	Diameter of aperture
Cash *et al.*, 1905	110–150			50–60
Deflandre, 1929	120–150		48–60	31–60
present work n = 20	92–178	77–137	40–72	35–70

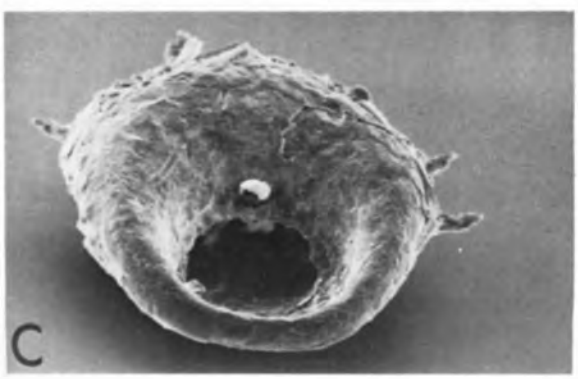
GEOGRAPHICAL DISTRIBUTION Argentina, Austria, Belgium, Brazil, British Isles, Bulgaria, Canada, Chile, Congo, Costa Rica, Faroes, France, Germany, Guatemala, Hungary, Iceland, Italy, Java, Marion I., Mexico, Morocco, Netherlands, Poland, Roumania, Russia, Spain, Sweden, Switzerland, Venezuela, West Africa.

REFERENCES Boltovskoy & Lena, 1974; Bonnet, 1966; Chardez, 1961*a*; Chibisova, 1967; Decloitre, 1947, 1948, 1949, 1954, 1965, 1966; Deflandre, 1926, 1929; Gal, 1969; Godenau *et al.*, 1973; Golemansky, 1970, 1973, 1974*b*; Gracia, 1972; Green, 1975; Grospietch, 1971; Hoogenraad & Groot, 1940*a*, 1940*b*; Laminger, 1972*a*, 1972*c*, 1973*b*, 1975; Lousier, 1976; Puytorac *et al.*, 1972; Rampi, 1947; Schönborn, 1969, 1975; Štěpánek, 1963; Vucetich, 1972.

Fig. A Apertural view × 680
Fig. B Lateral view × 390
Fig. C View of apertural rim × 390
Fig. D Shell at junction of smooth (upper right) and rough (bottom left) surfaces × 2800


A


B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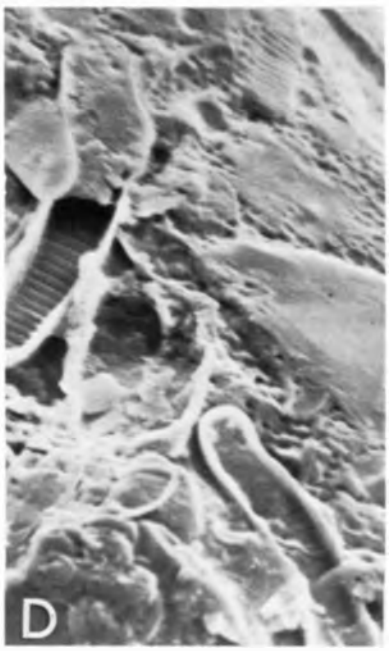

D

Centropyxis aerophila Deflandre, 1929

DESCRIPTION The shell is yellow or brown, ovoid and flattened in the apertural region (Figs. A and B). In lateral view the aboral region is spherical but tapers sharply near the aperture to form an apertural rim (Figs. A and B). The shell surface is usually rough and covered with extraneous material (Figs. D and E), except around the aperture and apertural rim where the surface is smooth (Figs. B and C). The aperture is invaginated, oval, and sub-terminal.

Variation in the size and shape of the shell and aperture in this species appears to be considerable, for example, when Deflandre (1929) described *C. aerophila* he also described two varieties *C. a.* var *sylvatica* and *C. a.* var. *sphagnicola*. He believed these descriptions were necessary to accommodate those specimens whose dimensions were outside those of the initial description.

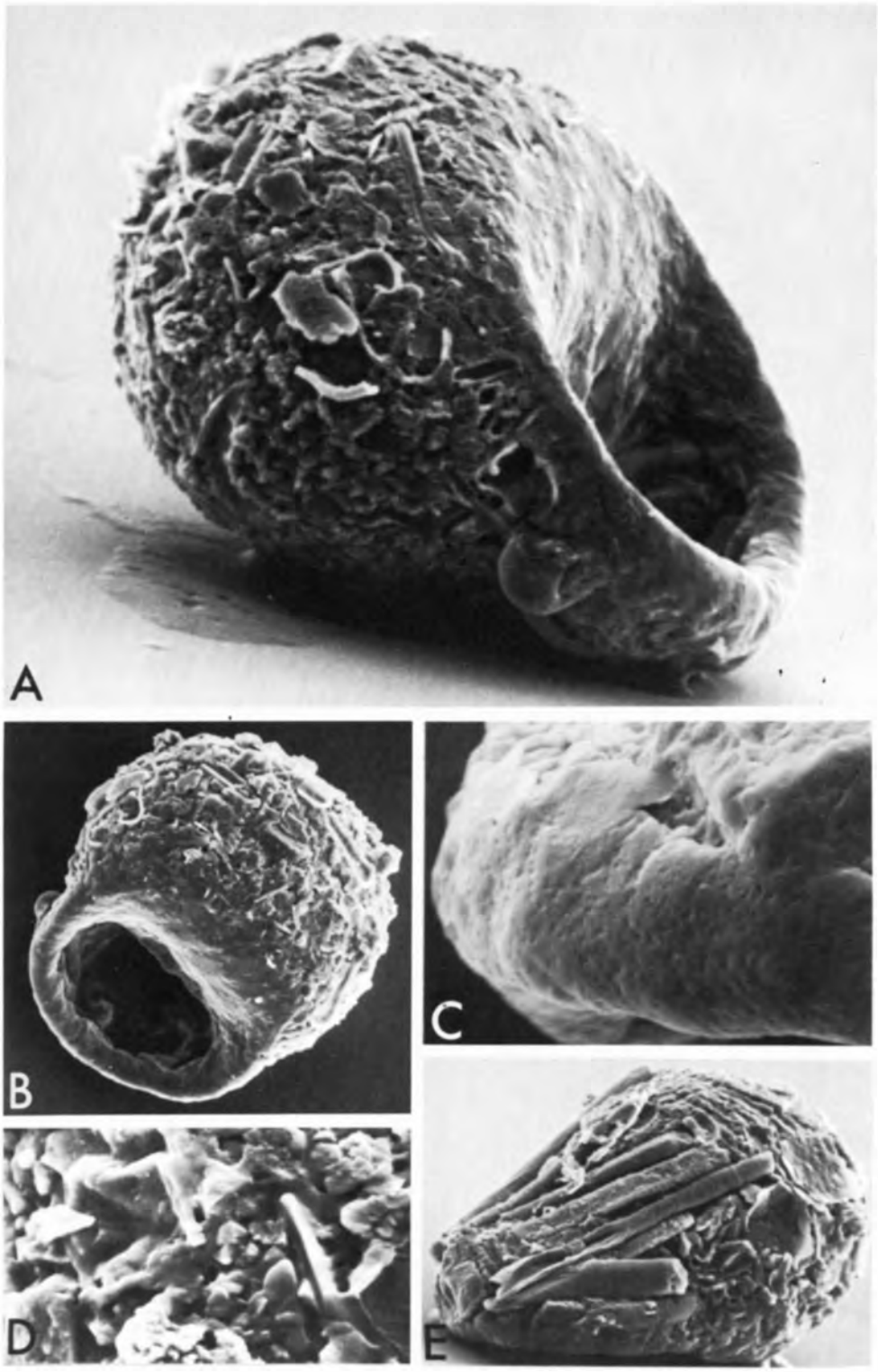
MEASUREMENTS (in μm)

Author	Length of shell	Breadth of shell	Depth of shell	Diameter of aperture
Deflandre, 1929	53–85	42–66		21–28
present work n=8	53–72	44–62	34–47	24–34

GEOGRAPHICAL DISTRIBUTION Annobón I., Austria, Balearic I., Belgium, British Isles, Bulgaria, Canada, Canary I., Chile, Congo, Corsica, Costa Rica, Czechoslovakia, France, Germany, Greece, Greenland, Guatemala, Hungary, India, Italy, Java, Luxembourg, Marion I., Madagascar, Morocco, Nepal, Netherlands, New Guinea, New Zealand, Poland, Roumania, Russia, Spain, United States of America, Venezuela, West Africa.

REFERENCES Bonnet, 1961, 1966, 1967*b*; Bonnet & Thomas, 1960; Chardez, 1961*a*, 1972; Decloitre, 1948, 1949, 1954, 1961*a*, 1965, 1966; Deflandre, 1929; Godenau *et al.*, 1973; Golemansky, 1970, 1973, 1974*b*; Gracia, 1963, 1965*a*, 1965*b*, 1968*a*; Hoogenraad & Groot, 1946; Laminger, 1972*b*, 1973*b*, 1975; Lousier, 1976; Nair & Mukherjee, 1966; Puytorac *et al.*, 1972; Schönborn, 1966; Štěpánek, 1963.

Fig. A Lateral view, showing invagination of aperture × 1400
Fig. B Apertural view × 680
Fig. C Part of apertural rim × 3900
Fig. D Section of rough shell surface × 3700
Fig. E Lateral view × 740


A
B
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D
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Centropyxis cassis (Wallich, 1864)

DESCRIPTION The shell is brown, ovoid, and in outline the sides are usually parallel becoming semi-circular at the extremities (Fig. A). In lateral view it is spherical in the aboral region and tapers towards the aperture (Fig. B). It is composed of sand grains roughly arranged over most of the shell, except in the apertural region which appears smooth (Figs. A and C). This smoothness, unlike *C. aerophila* (see p. 48), is not due to a thick overlying layer of organic cement. The aperture is invaginated, oval, subterminal and has a pronounced rim (Figs. A and C).

This species is of a similar size to *C. aerophila* and *C. platystoma*, but can be easily distinguished from them by its shape and lack of thick cement around the aperture. A variety with spines, *C. c. spinifera*, is listed by Deflandre (1929).

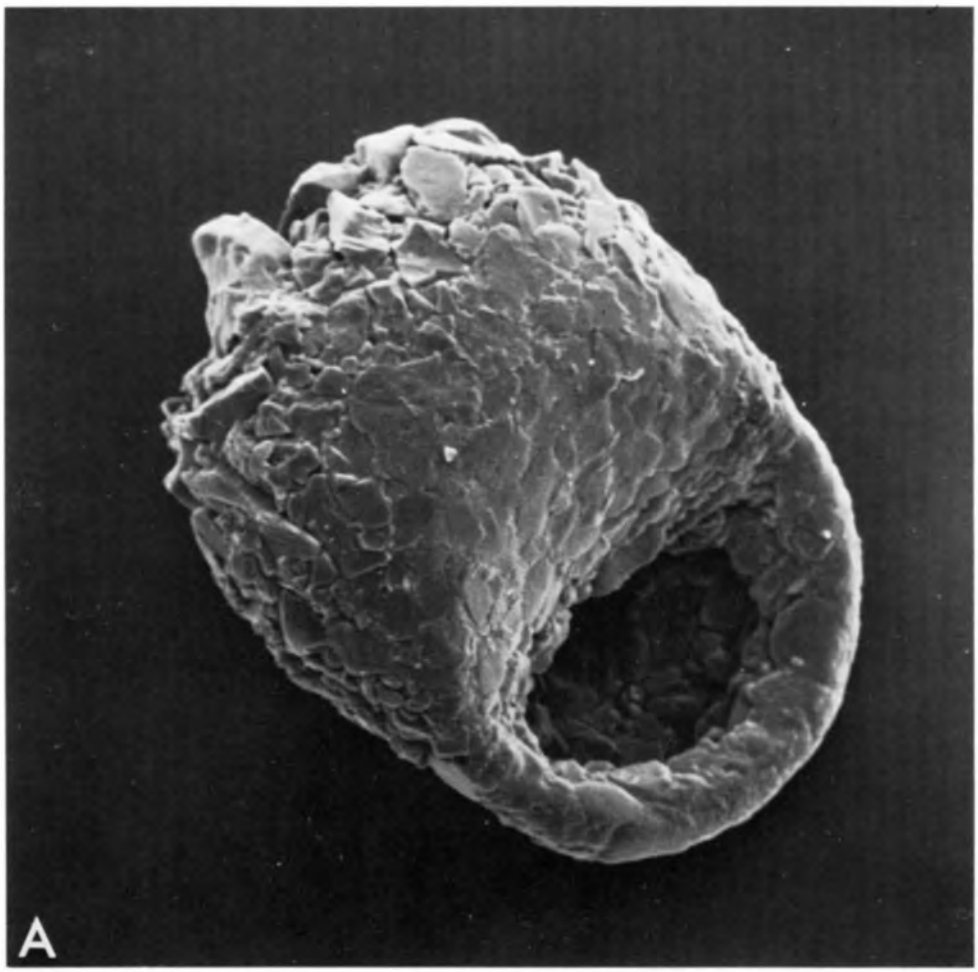
MEASUREMENTS (in μm)

Author	Length of shell	Breadth of shell	Depth of shell	Diameter of aperture
Deflandre, 1929	60–86	50–73		
present work n = 2	79–117	57–90	41–63	31–49

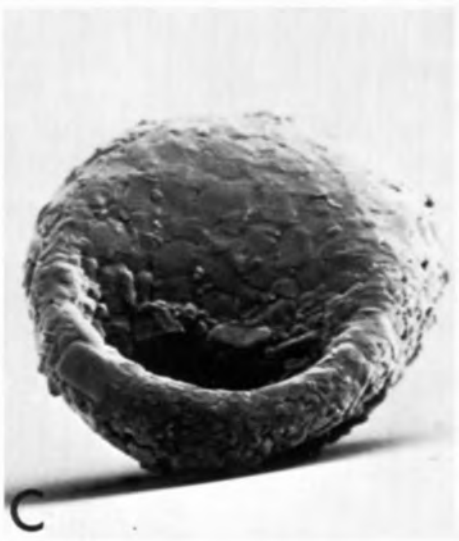
GEOGRAPHICAL DISTRIBUTION Annobón I., Argentina, Austria, Belgium, Brazil, British Isles, Canada, Chile, Congo, Costa Rica, Czechoslovakia, France, Germany, Greece, Guatemala, Luxembourg, Iceland, Italy, Java, Madagascar, Malacca, Marion I., Poland, Rodriquez I., Roumania, Russia, Spain, Sumatra, Sweden, United States of America, Venezuela.

REFERENCES Boltovskoy & Lena, 1966, 1971; Bonnet, 1966, 1967*b*; Chardez, 1961*a*; Decloitre, 1948, 1949, 1954, 1965; Deflandre, 1929; Godenau *et al.*, 1973; Golemansky, 1970; Graaf, 1956; Gracia, 1963, 1972; Green, 1975; Grospietch, 1971; Hoogenraad & Groot, 1940*a*, 1940*b*; Laminger, 1973*b*, 1975; Lousier, 1976; Oye, 1949; Puytorac *et al.*, 1972; Rampi, 1947; Štěpánek, 1963.

Fig. A Apertural view × 1400
Fig. B Lateral view × 810
Fig C View of apertural rim × 930


A


B


C

Centropyxis constricta (Ehrenberg, 1841)

DESCRIPTION The shell is yellow or brown, and ovoid (Figs. A and B). The aboral region in lateral view is spherical but flattened slightly towards the aperture (Fig. D). The shell is usually smooth on the apertural surface (Fig. C) and rough at the aboral region (Fig. E). The aperture is invaginated, circular or oval, subterminal and has a semi-circular apertural rim (Fig. B).

Previous descriptions (Penard, 1902; Deflandre, 1929) refer to differences in the shape due to the materials used in constructing the shell. *C. constricta* is similar to *C. aerophila* and *C. ecornis*, but can be readily distinguished from them by the shape and position of the aperture and shell size. The specimens we examined appear to be larger than Deflandre's (1929) but otherwise agree well with his description.

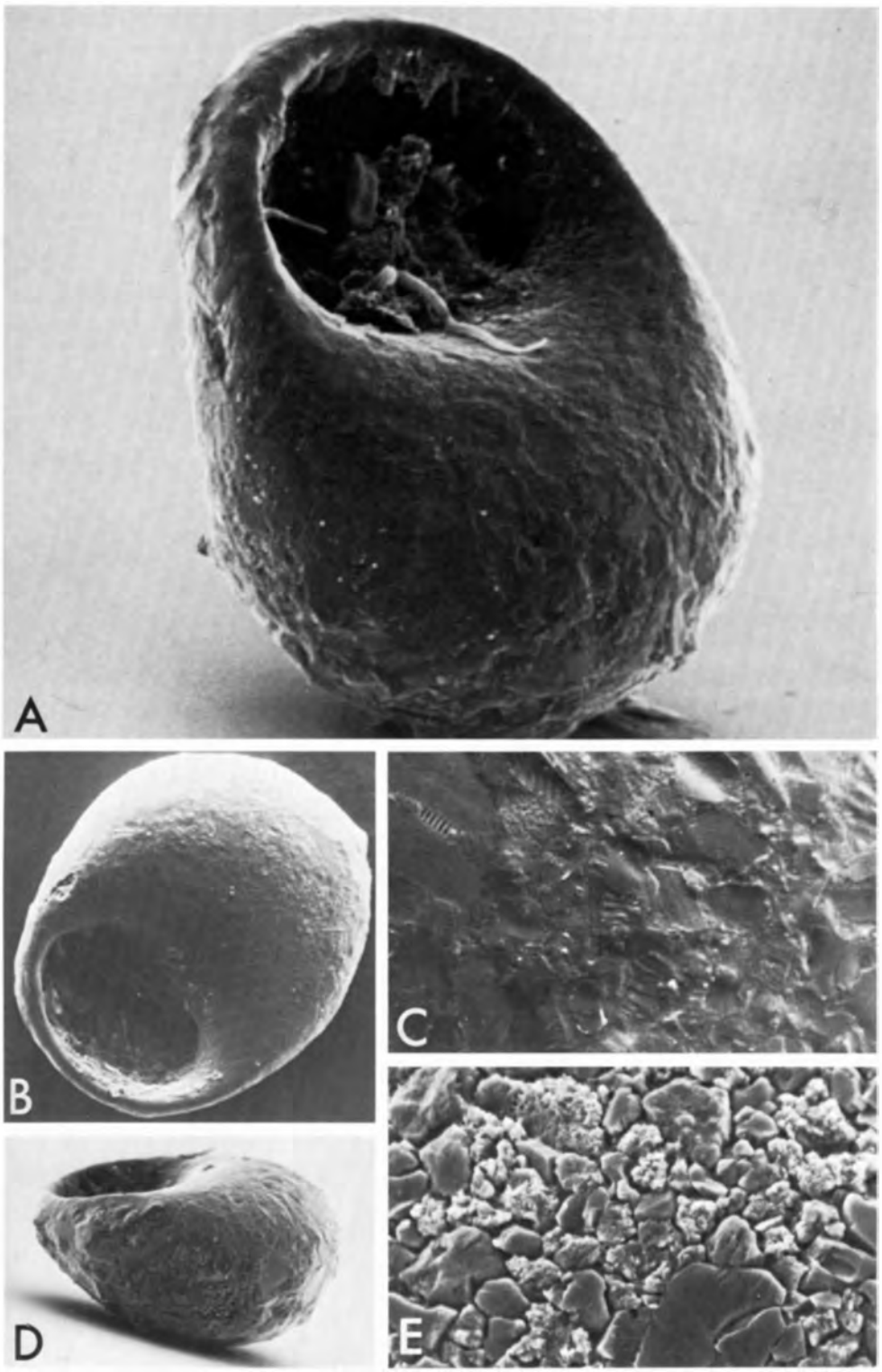
MEASUREMENTS (in μm)

Author	Length of shell	Breadth of shell	Depth of shell	Diameter of aperture
Deflandre, 1929	120–150	75–100		
present work n = 10	144–181	132–148	82–102	62–85

GEOGRAPHICAL DISTRIBUTION Annobón I., Argentina, Austria, Balearic I., Belgium, Brazil, British Isles, Bulgaria, Canada, Canary I., Chile, Costa Rica, Elephant I., Faroes, France, Germany, Guatemala, Hungary, Iceland, Marion I., Mexico, Morocco, Poland, Roumania, Russia, Spain, Spitzbergen, Sweden, Switzerland, United States of America, Venezuela, West Africa.

REFERENCES Boltovskoy & Lena, 1966, 1971, 1974; Bonnet, 1966; Decloitre, 1948, 1949, 1954, 1965, 1966; Deflandre, 1929; Chardez, 1961; Chibisova, 1967; Gal, 1969; Godenau *et al.*, 1973; Golemansky, 1970, 1973, 1974*b*; Graaf, 1956; Gracia, 1963, 1965*a*, 1965*b*, 1972; Green, 1975; Grospietch, 1971, 1975; Hoogenraad & Groot, 1940*a*, 1940*b*; Laminger, 1973*b*, 1975; Puytorac *et al.*, 1972; Schönborn, 1975; Smith, 1972; Štěpánek, 1963.

Fig. A Lateral view of aperture × 540
Fig. B Apertural view × 270
Fig. C Section of apertural surface × 1800
Fig. D Lateral view × 280
Fig. E Rough portion of shell in aboral region × 1700


A
B
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Centropyxis discoides Penard, 1890

DESCRIPTION The shell is brown, circular and in lateral view discoid (Figs. A and D). The apertural surface is usually smooth (Figs. B & C), whilst the aboral surface is rough and covered with sand grains (Figs. D and E). Small spines may project from the lateral margins, similar to those of *C. aculeata*, but they are absent on the illustrated specimen. The aperture is invaginated, circular and either central or subcentral (Figs. A and C).

Variation seems to be restricted to the presence or absence of spines, although large specimens are reported by Deflandre (1929).

MEASUREMENTS (in μm)

Author	Length of shell	Depth of shell	Diameter of aperture
Cash *et al.*, 1919	150–300	38–75	50–100
present work n=2	202–240	63–65	69–71

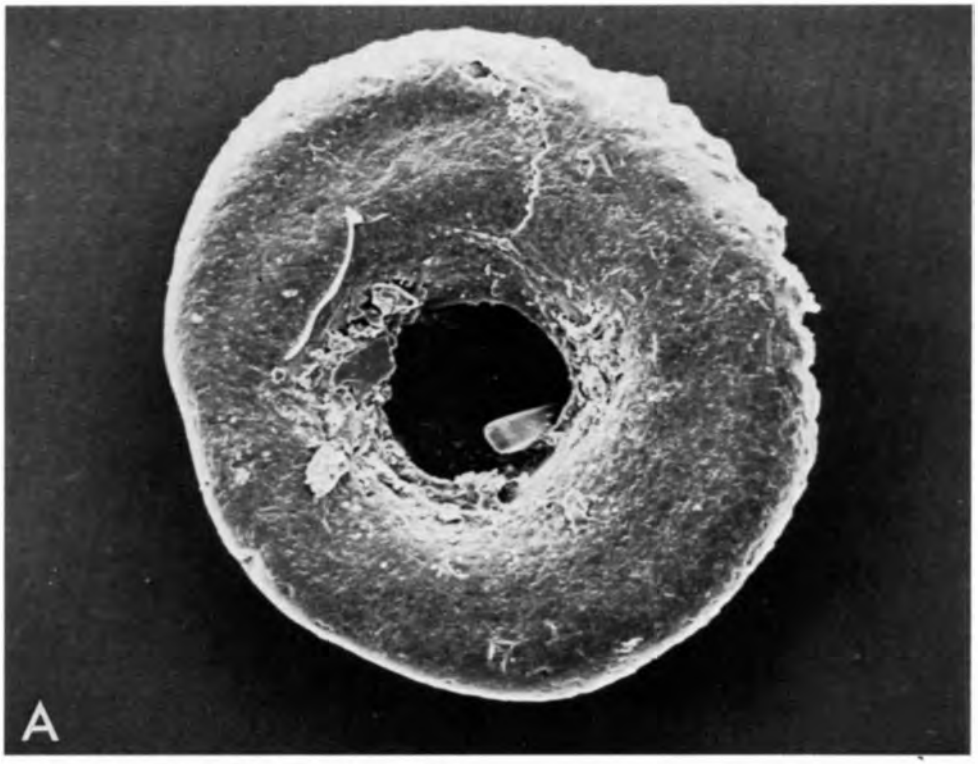
GEOGRAPHICAL DISTRIBUTION Argentina, Austria, Belgium, Brazil, British Isles, Canada, Canary I., Colombia, Congo, Czechoslovakia, Denmark, Finland, France, Germany, Guatemala, Hungary, Mexico, Netherlands, Poland, Roumania, Russia, Spain, Sweden, Switzerland, United States of America, Venezuela, West Africa.

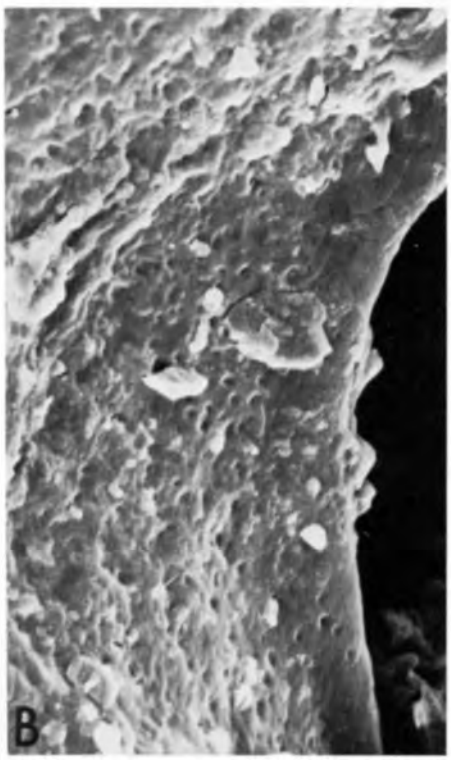
REFERENCES Chardez, 1961*a*; Decloitre, 1965; Deflandre, 1926, 1929; Godenau *et al.*, 1973; Golemansky, 1970; Graaf, 1956; Green, 1975; Grospietch, 1958*b*; Laminger, 1971, 1973*b*, 1975; Lousier, 1976; Schönborn, 1975; Štěpánek, 1963; Vucetich, 1972.

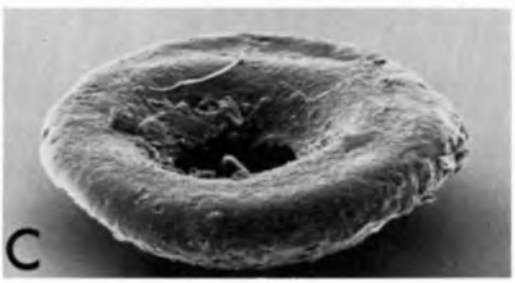
Fig. A Apertural view × 400

Fig. B Portion of apertural margin to show the proteinaceous nature of the shell × 2200

Figs, C, D and E Varying lateral views of the same specimen × 220


A


B


C


D


E

Centropyxis ecornis (Ehrenberg, 1841)

DESCRIPTION The shell is brown and usually circular (Fig. A). In lateral view the aboral region is spherical and tapers from the mid-body position to the apertural lip (Fig. B). The shell is rough (Fig. C), although the apertural surface usually has a covering of organic cement overlying the irregular mineral particles (compare Figs. D and E). The aperture is invaginated, oval or circular, sub-terminal with a thick apertural rim (Figs. A and B).

Variation in this species appears to be restricted to size and shape (Deflandre, 1929).

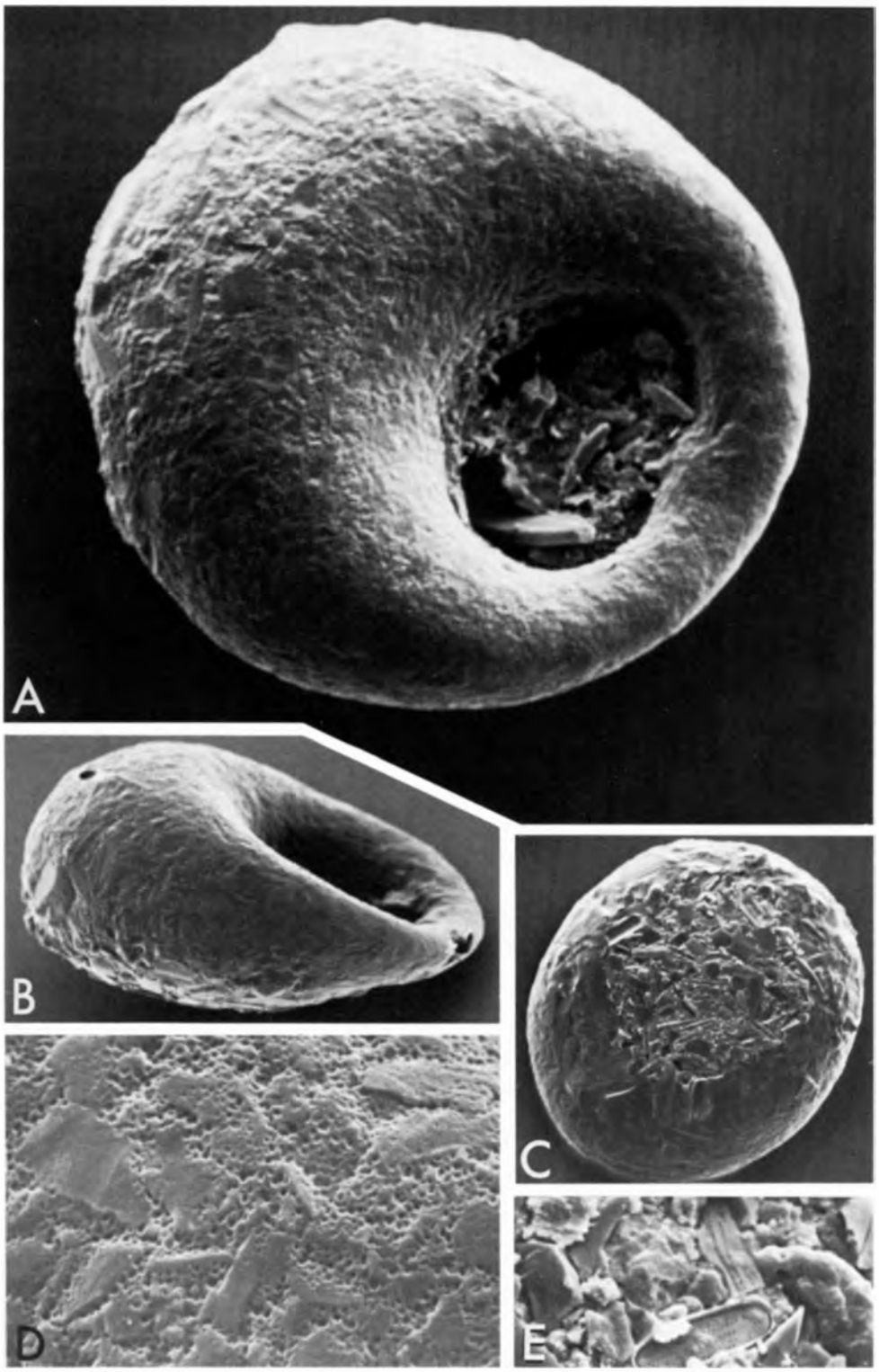
MEASUREMENTS (in μm)

Author	Length of shell	Breadth of shell	Depth of shell	Diameter of aperture
Deflandre, 1929	191–244	185–234		
present work n = 5	199–262	182–254	82–116	72–98

GEOGRAPHICAL DISTRIBUTION Angola, Argentina, Australia, Austria, Belgium, Brazil, British Isles, Bulgaria, Canada, Chile, China, Congo, Czechoslovakia, Finland, France, Germany, Guatemala, Haiti, Iceland, Italy, Java, Mexico, Netherlands, New Zealand, Roumania, Sikkim, Sweden, Switzerland, United States of America, Venezuela, West Africa.

REFERENCES Boltovskoy & Lena, 1971, 1974; Bonnet, 1960, 1966, 1967*a*; Chardez, 1961*a*; Chibisova, 1967; Decloitre, 1954, 1965; Deflandre, 1929; Godenau *et al.*, 1973; Golemansky, 1974*b*; Green, 1975; Grospietch, 1958*a*, 1975; Hoogenraad & Groot, 1940*a*, 1940*b*; Laminger, 1973*b*, 1975; Oye van, 1949; Puytorac *et al.*, 1972; Schönborn, 1975; Štěpánek, 1963; Vucetich, 1972.

Fig. A Apertural view × 450
Fig. B Lateral view × 260
Fig. C Aboral view × 240
Fig. D Portion of apertural surface to show the organic cement pattern × 1700
Fig. E Portion of aboral region to illustrate the rough surface × 1850


A
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Centropyxis hirsuta Deflandre, 1929

DESCRIPTION The shell is colourless, yellow or brown, usually circular and has several lateral spines (Fig. A). In lateral view it is spherical and tapers rapidly at the apical region (Fig. C). There are two lateral pores or indentations situated on a level with the anterior margin of the aperture (Fig. B). The aperture is invaginated, oval, sub-terminal and has a distinct posterior margin (Fig. A).

Although the specimens described here are from a laboratory clonal culture and therefore have a mainly organic shell, specimens described from a natural environment also appear to lack added mineral particles (Deflandre, 1929; Green, 1975).

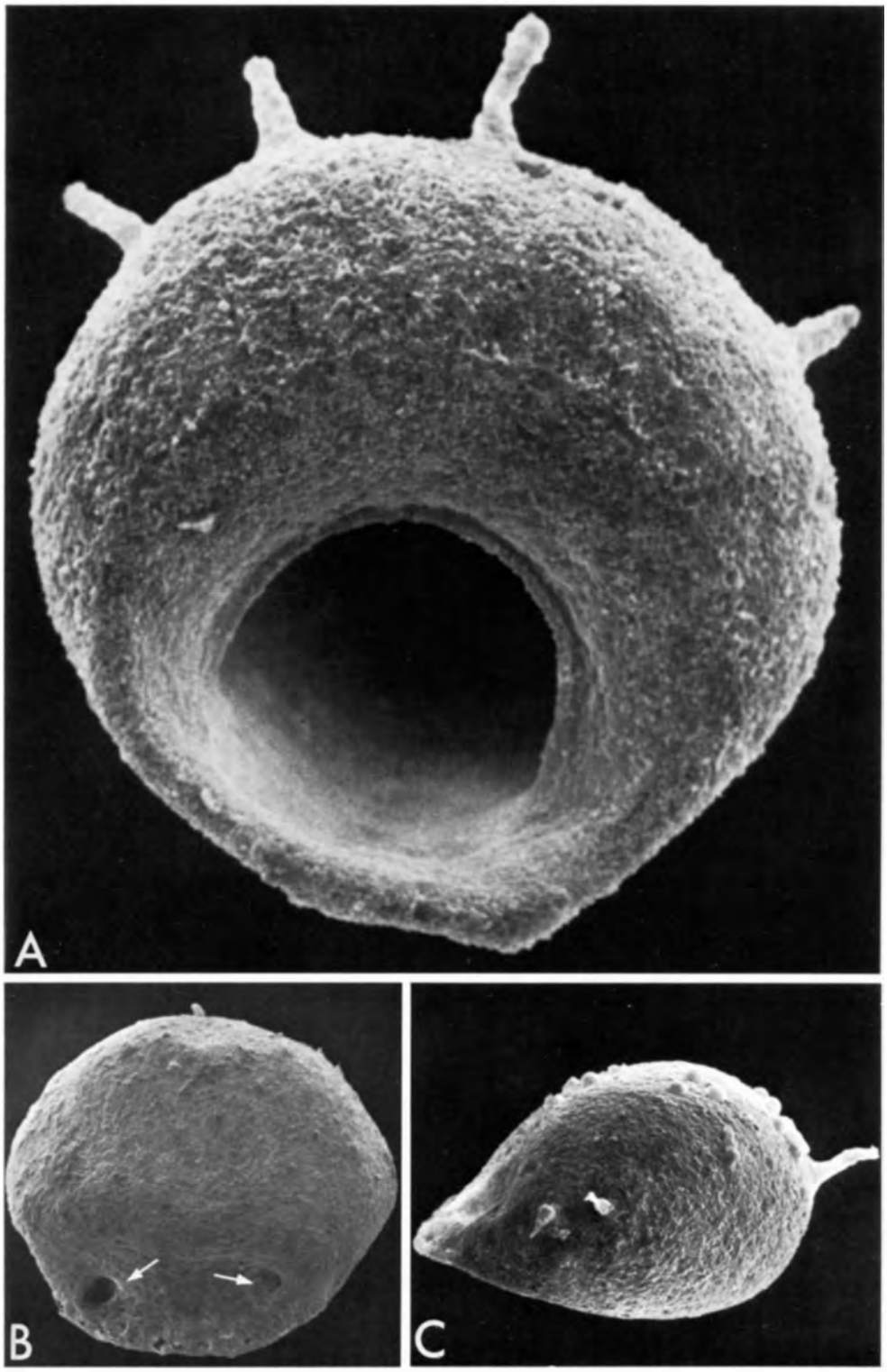
MEASUREMENTS (in μm)

Author	Length of shell	Breadth of shell	Depth of shell	Diameter of aperture
Deflandre, 1929	72–88	42–54		
present work n = 4	72–85	81–87	44–51	33–50

GEOGRAPHICAL DISTRIBUTION Argentina, Austria, British Isles, Chile, France, Germany, Poland, Roumania, Sweden, Venezuela, West Africa.

REFERENCES Decloitre, 1954; Deflandre, 1929; Godenau *et al.*, 1973; Grospietch, 1958*b*, 1975; Hedley *et al.*, 1976; Laminger, 1971, 1972*c*; Schönborn, 1966, 1975; Vucetich, 1972.

Fig. A Apertural view × 1300
Fig. B View showing the two lateral pores (arrowed) and aboral surface × 600
Fig. C Lateral view to illustrate the flattening at the apertural region × 690


A
B
C

Centropyxis platystoma Penard, 1890

DESCRIPTION The shell is yellow or brown, oval or elongate, and often has a constriction at the aperture to form a neck (Fig. A). In lateral section it is spherical aborally and flattened in the apical region (Fig. B). The shell surface is usually rough, but has a smooth apertural rim (Figs. C and D). The aperture is invaginated, circular, and sub-terminal (Figs. A, C and D).

There appear to be three major areas of variation in this species, the degree of invagination of the aperture, the constriction of the neck and the shape of the shell (Deflandre, 1929).

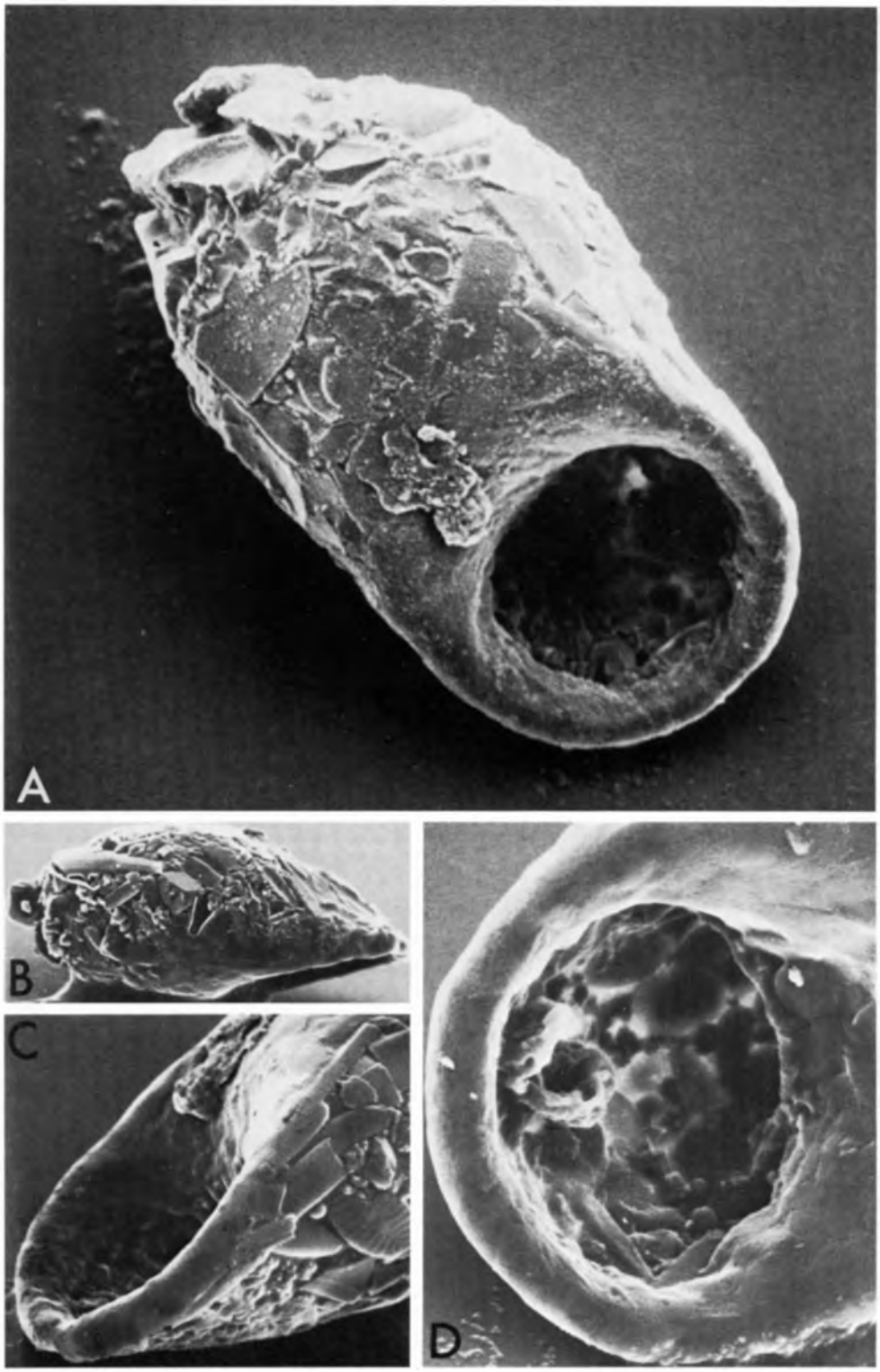
MEASUREMENTS (in μm)

Author	Length of shell	Breadth of shell	Depth of shell	Diameter of aperture
Deflandre, 1929	63–95	36–64		24–38
present work n = 8	62–81	34–48	25–31	19–27

GEOGRAPHICAL DISTRIBUTION Austria, Belgium, British Isles, Canada, Congo, Costa Rica, Czechoslovakia, East Africa, France, Germany, Guatemala, Italy, Marion I., Mexico, Morocco, Netherlands, New Guinea, Poland, Roumania, Russia, Spain, Sweden, Switzerland, United States of America, West Africa.

REFERENCES Bonnet & Thomas, 1960; Chardez, 1961*a*; Chibisova, 1967; Decloitre, 1965, 1966; Deflandre, 1929; Godenau *et al.*, 1973; Golemansky, 1970, 1973; Graaf, 1968; Gracia, 1968*a*; Grospietch, 1958*a*, 1971; Laminger, 1973*b*, 1975; Lousier, 1976; Puytorac *et al.*, 1972; Schönborn, 1969, 1975; Štěpánek, 1963, 1967.

Fig. A Apertural view × 1700
Fig. B Lateral view × 780
Fig. C Lateral view of aperture × 1550
Fig. D View of aperture to show the smooth apertural rim × 1750


A
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Centropyxis spinosa Cash, 1905

DESCRIPTION The shell is yellow or brown, ovoid or circular and has about six lateral spines (Fig. A). In lateral view it is spherical but tapers towards the apical region (Fig. B). The shell surface is usually rough and covered with sand grains or diatom shells (Figs. A and B), whilst the area around the aperture is smooth (Fig. C). This latter region is occasionally encrusted with extraneous matter, but usually shows the organic matrix of the shell (Fig. D). The aperture is invaginated, oval or uneven in outline, has two lateral internal extensions that divide the opening (Fig. C), and is excentric in position (Figs. A and C).

Cash (1905) suggested that this species differed from *C. aculeata* in the structure of the shell, being delicate, more compressed, with more spines and having a lobate aperture. This species appears to vary like *C. aculeata* in the number of spines and the size of the shell, but is easily distinguished by the internal extensions of the aperture.

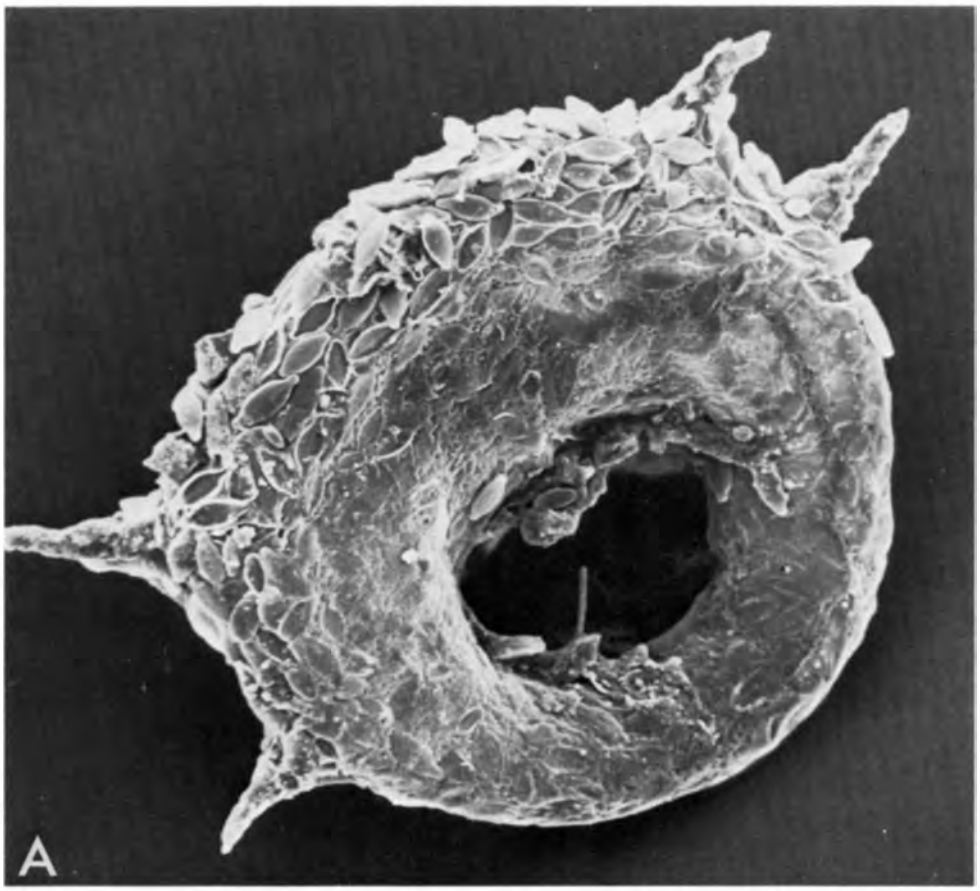
MEASUREMENTS (in μm)

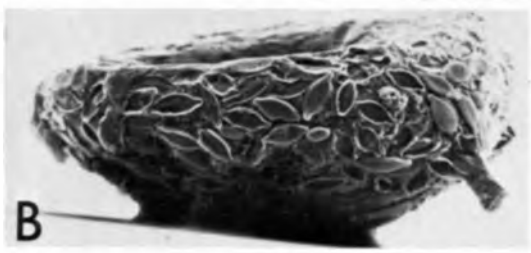
Author	Length of shell	Breadth of shell	Depth of shell	Diameter of aperture
Cash *et al.*, 1905	120–140		30–40	
present work n=7	105–141	84–137	34–45	27–51

GEOGRAPHICAL DISTRIBUTION Austria, Belgium, British Isles, Costa Rica, France, Germany, Russia, South Africa, West Africa.

REFERENCES Decloitre, 1948, 1949; Deflandre, 1929; Chardez, 1961*a*; Chibisova, 1967; Jung, 1936*a*; Laminger, 1973*b*, 1975.

Fig. A Apertural view × 640
Fig. B Lateral view × 470
Fig. C Lateral view of aperture, to illustrate one of the apertural supports (arrowed) × 390
Fig. D Portion of surface around the aperture showing the organic shell matrix × 3900


A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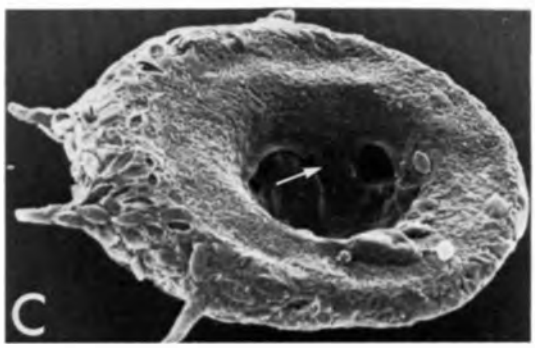
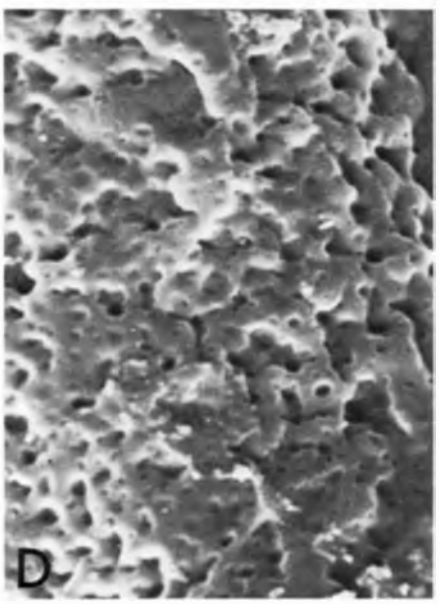

C


D

Bullinularia indica (Penard, 1907)

DESCRIPTION The shell is dark brown, oval or circular, and hemispherical or spherical in lateral view (Figs. A and C). The shell surface is usually rough, except around the aperture where it is smooth (Figs. A, B and D). The aperture is an invaginated narrow, elongated slit, whose inner lip is depressed and outer lip incurved with a median extension (Figs. A and B). Large pores surround the aperture, they are more numerous on the outer lip and extend laterally over the apical margin (Figs. B and D).

Some variation of the aperture and surrounding pores has been observed (Cash *et al.*, 1919).

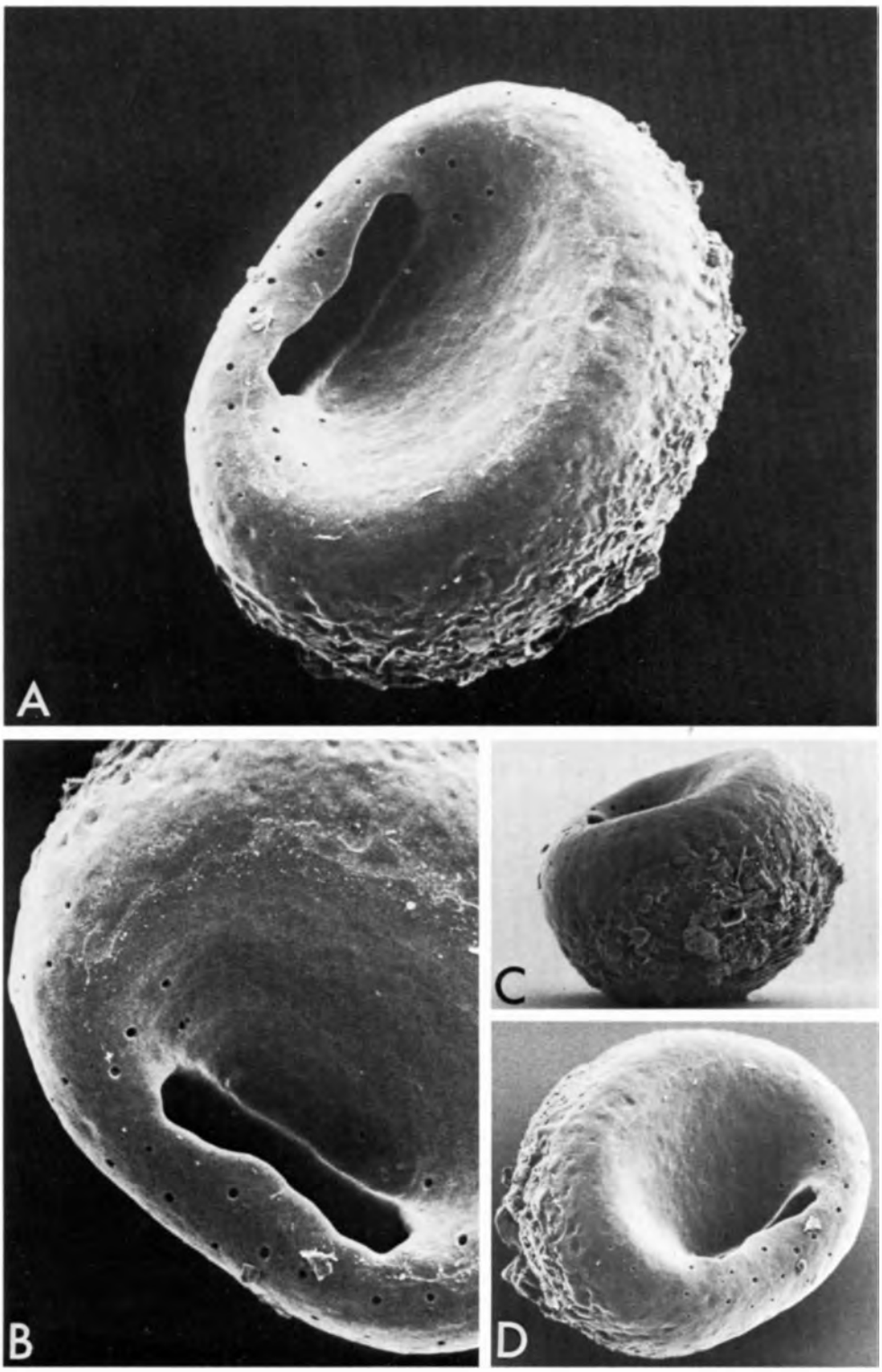
MEASUREMENTS (in μm)

Author	Diameter of shell	Breadth of shell	Depth of shell	Diameter of aperture
Cash *et al.*, 1919	140–180			70–90
present work n = 3	138–148	165–172	94–99	65–69

GEOGRAPHICAL DISTRIBUTION Belgium, Brazil, British Isles, Bulgaria, Canada, Central America, Chile, Congo, Czechoslovakia, Germany, Greece, Java, New Zealand, Sumatra, Switzerland, Uganda.

REFERENCES Boltovskoy & Lena, 1971, 1974; Bonnet, 1961, 1966, 1967*a*, 1967*b*; Bonnet & Thomas, 1960; Chardez, 1961*a*; Graaf, 1956; Golemansky, 1974*b*; Grospietch, 1958*a*; Heal, 1963*b*; Hoogenraad & Groot, 1940*a*, 1940*b*, 1948; Jung, 1936*a*; Štěpánek, 1963, 1967; Thomas, 1959.

Fig. A Apertural view × 470
Fig. B View of aperture to show detail of lips and pores × 570
Fig. C Lateral view × 300
Fig. D View to show pores on the apical margin × 290


A
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Trigonopyxis arcula (Leidy, 1879)

DESCRIPTION The shell is yellow or brown, circular, and hemispherical in lateral view (Figs. A and B). The apertural surface is smooth and slightly invaginated (Fig. A), the organic cement that covers the apertural surface extends over the rim of the shell (Figs. B and D), and the aboral surface is rough (Fig. C). The aperture is triangular, central and surrounded by a small collar (Figs. A and B).

Specimens with irregular and quadrangular apertures are described by Cash *et al.*, (1909).

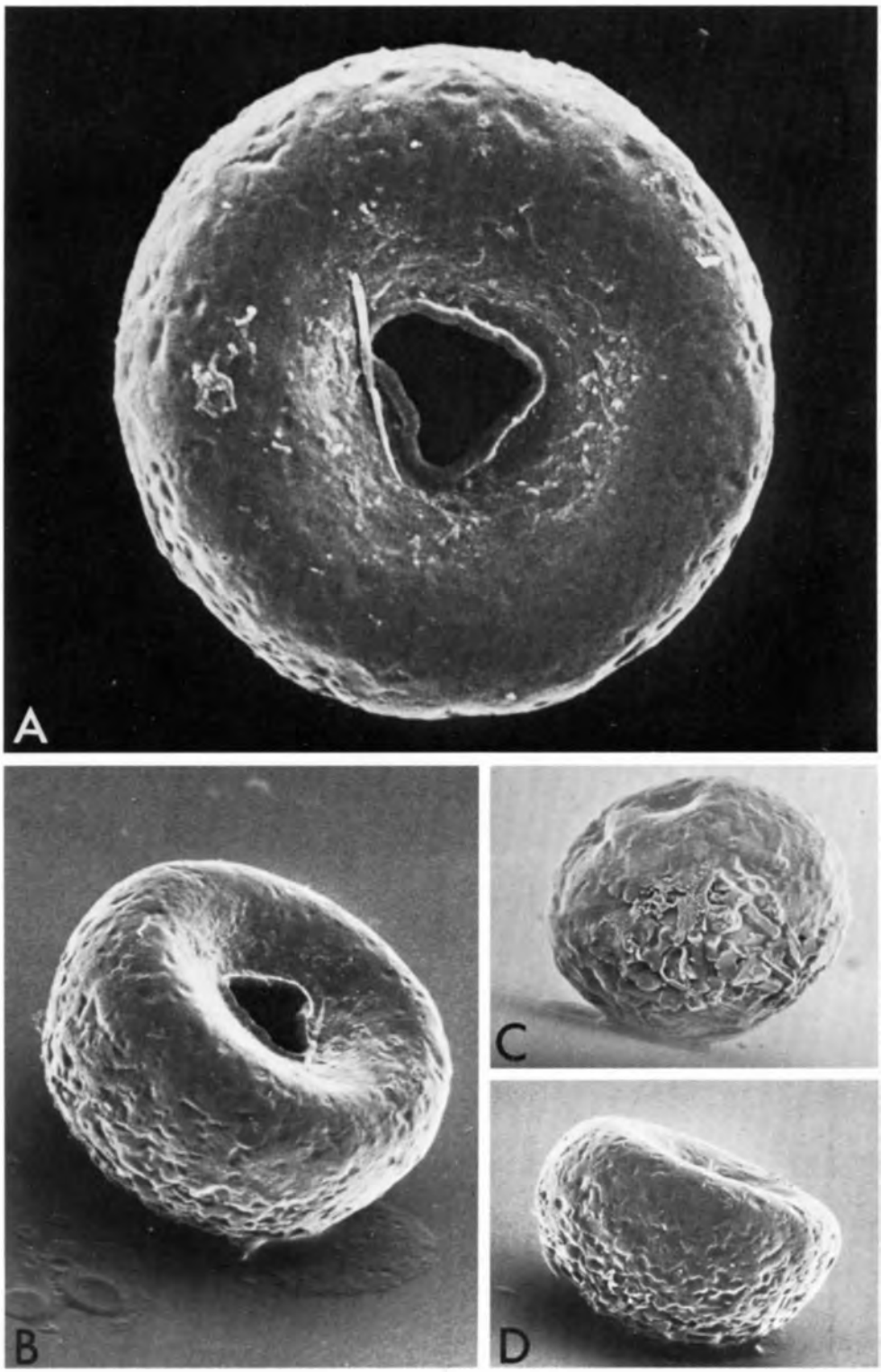
MEASUREMENTS (in μm)

Author	Diameter of shell	Depth of shell	Diameter of aperture
Cash *et al.*, 1909	90	40–45	
Bonnet and Thomas, 1960	108–153	75–80	24–45
present work n = 7	95–168	58–88	21–42

GEOGRAPHICAL DISTRIBUTION Angola, Annobón I., Argentina, Balearic I., Belgium, British Isles, Chile, France, Germany, Java, Marion I., Mexico, New Guinea, New Zealand, Spain, Sumatra, Switzerland, West Africa.

REFERENCES Boltovskoy & Lena, 1974; Bonnet, 1960, 1966, 1967*a*; Chardez, 1961*a*; Decloirete, 1955; Gracia, 1963, 1965*a*, 1968*a*, 1972; Grospietch, 1971; Heal, 1963*b*; Hoogenraad & Groot, 1940*b*, 1948; Jung, 1936*a*, 1936*b*; Laminger, 1973*b*; Puytorac *et al.*, 1972.

Fig. A Apertural view × 920
Fig. B View to show the apertural collar × 590
Fig. C Aboral view to show rough surface × 400
Fig. D Lateral view × 430


A
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Cyclopyxis eurystoma (Deflandre, 1929)

DESCRIPTION The shell is yellow or brown, circular, and hemispherical in lateral view (Figs. A and B). The shell surface is rough except for the apertural collar (Figs. A and B). The aperture is circular, central and bordered by a smooth band of organic cement (Figs. B and C).

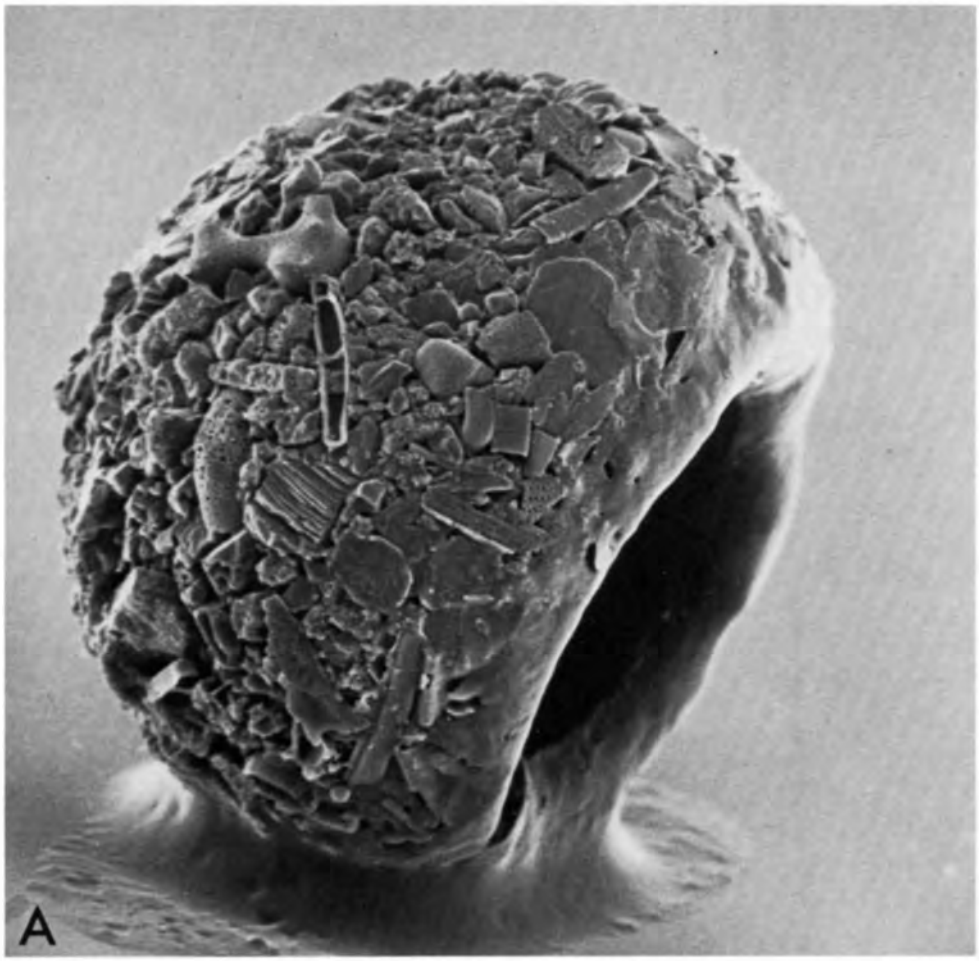
MEASUREMENTS (μm)

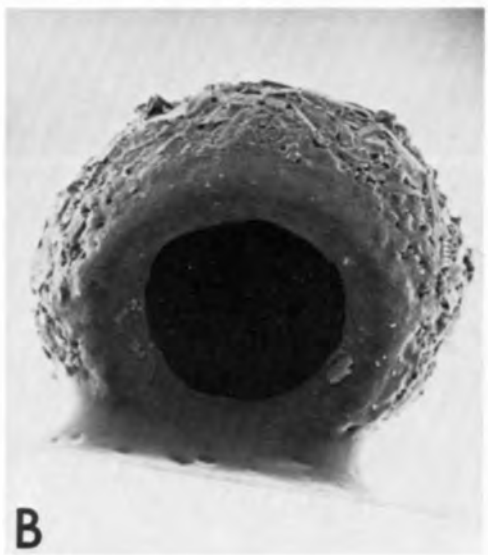
Author	Diameter of shell	Depth of shell	Diameter of aperture
Deflandre, 1929	60–66	49–52	32–34
Bonnet and Thomas, 1960	45–65	30–50	23–33
present work n = 6	69–80	46–55	34–46

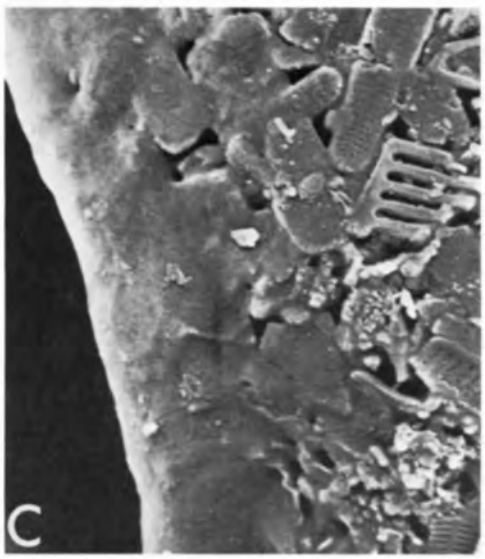
GEOGRAPHICAL DISTRIBUTION Algeria, Angola, Annobón I., Belgium, British Isles, Bulgaria, Canada, Chile, Congo, Czechoslovakia, France, Germany, Greenland, Hungary, Iceland, Italy, Java, Luxembourg, Madagascar, Morocco, Poland, Roumania, Spain, Sweden, Venezuela, West Africa.

REFERENCES Bonnet, 1960, 1966; Chardez, 1961*a*; Decloitre, 1949, 1961*b*, 1965; Deflandre, 1929; Godenau *et al.*, 1973; Golemansky, 1970, 1974*b*; Gracia, 1963, 1972; Grospietch, 1958*b*, 1975; Lousier, 1976; Oye van, 1949; Puytorac *et al.*, 1972; Rampi, 1947; Štěpánek, 1963.

Fig. A Lateral view × 1470
Fig. B Apertural view × 660
Fig. C Portion of apertural collar to show the smooth organic cement × 2600


A


B


C

Cyclopyxis kahli (Deflandre, 1929)

DESCRIPTION The shell is brown, circular, and hemispherical in lateral view (Figs. A and C). The apertural surface is slightly invaginated and smooth (Figs. B and C), whereas the aboral surface is rough (Fig. E). The aperture is circular, central and surrounded by small rough particles (Fig. D).

This species is similar to *C. arcelloides* (Penard, 1902) but differs from it in size and the diameter of the aperture.

MEASUREMENTS (in μm)

Author	Diameter of shell	Depth of shell	Diameter of aperture
Deflandre, 1929	80–85	55–60	24–25
Bonnet and Thomas, 1960	80–98	55–63	24–29
present work n=7	77–105	43–61	24–36

GEOGRAPHICAL DISTRIBUTION Algeria, Belgium, British Isles, Brazil, Bulgaria, Canada, Chile, Costa Rica, Czechoslovakia, France, Germany, Greece, Guatemala, Iceland, Nepal, Poland, Roumania, Switzerland, Venezuela, West Africa.

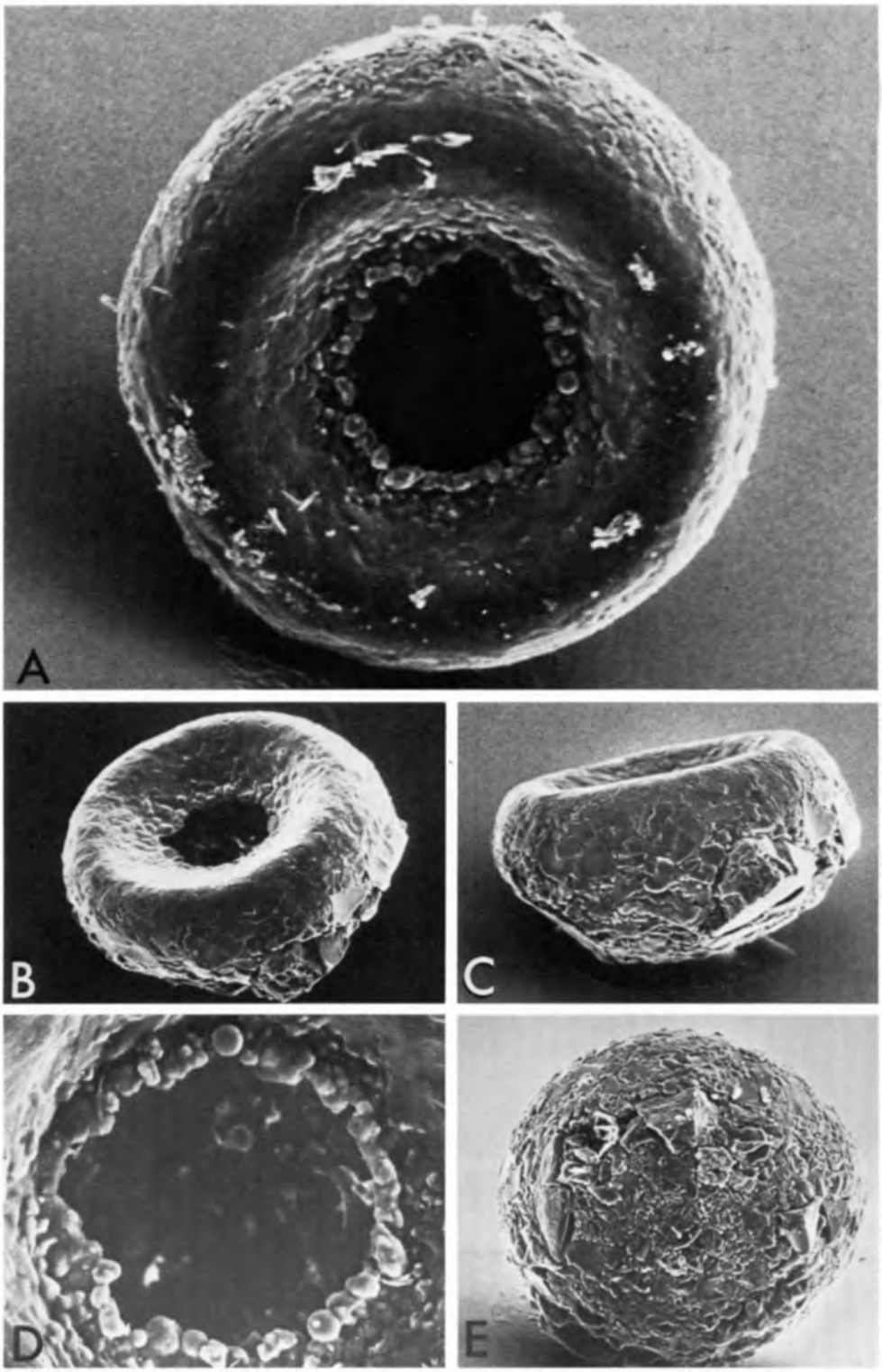
REFERENCES Bonnet, 1966, 1967*a*, 1967*b*; Decloitre, 1965; Deflandre, 1929; Godenau *et al.*, 1973; Golemansky, 1970, 1974*b*; Green, 1975; Grospietch, 1958*b*, 1975; Laminger, 1972*b*, 1973*b*; Lousier, 1976; Puytorac *et al.*, 1972; Štěpánek, 1963.

Fig. A Apertural view × 880

Fig. B & C Lateral views to show the division of the rough and smooth surfaces × 450 & 480

Fig. D View to show distribution of particles around the aperture × 1200

Fig. E Aboral view × 460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Hyalosphenia papilio Leidy, 1875

DESCRIPTION The shell is colourless or yellow, ovoid, smooth and laterally flattened (Figs. A and C). A lateral pore is present, at about the mid-body region, on each side (Figs. C and D). The aperture is terminal and surrounded by a small collar (Figs. A, B and E).

Two forms of this species have been described and listed by Grospietsch (1965) in his review of the genus, which are characterized by either having several pores or a concave aperture.

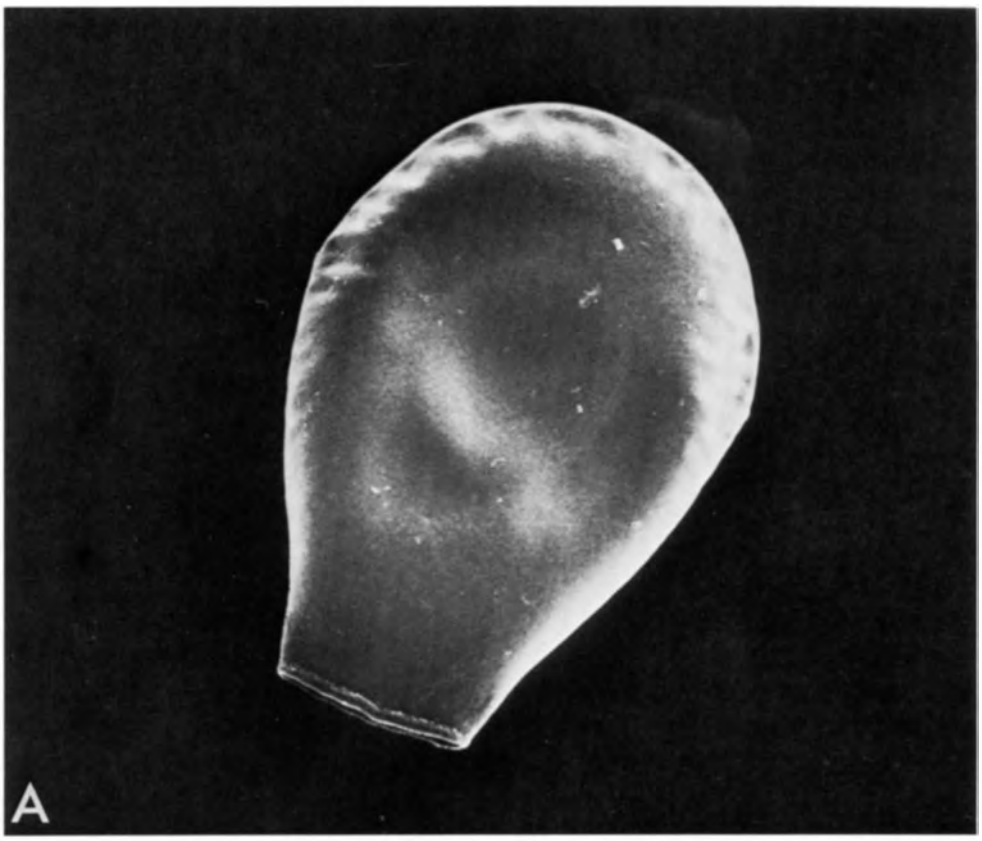
MEASUREMENTS (in μm)

Author	Length of shell	Breadth of shell	Depth of shell	Diameter of aperture
Cash *et al.*, 1909	110–140			
Grospietsch, 1965	90–175	60–115		
present work n = 3	111–133	81–91	21–25	32–40

GEOGRAPHICAL DISTRIBUTION Annobón I., Argentina, Austria, Belgium, Brazil, British Isles, Bulgaria, Canada, Colombia, Czechoslovakia, East Africa, Finland, France, Germany, Hungary, Iceland, Japan, Madagascar, Marion I., Netherlands, Roumania, Russia, Spain, Sweden, Switzerland, United States of America.

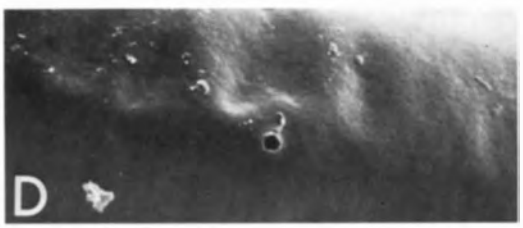
REFERENCES Charret, 1962; Decloitre, 1965; Gal, 1969; Graaf, 1956; Gracia, 1963; Grospietch, 1965, 1971; Haeck, 1956; Heal, 1963*b*; Joyon & Charret, 1962; Jung, 1936*a*; Laminger, 1972*a*, 1975; Puytorac *et al.*, 1972; Steinecke, 1914.

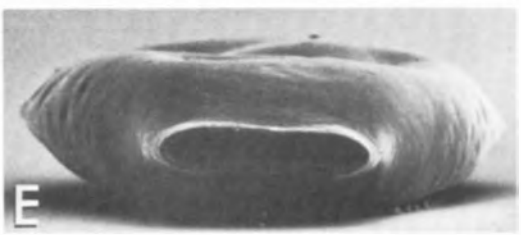
Fig. A Broad lateral view × 630
Fig. B Lateral view of aperture × 4800
Fig. C Narrow lateral view × 430
Fig. D Portion of shell to show lateral pore × 1500
Fig. E Apertural view × 590


A


B


C


D


E

Hyalosphenia subflava Cash and Hopkinson, 1909

DESCRIPTION The shell is colourless or yellow, ovoid and smooth (Fig. A). It is elliptical in narrow view (Fig. C) and oval in apertural view (Fig. B). The aperture is terminal, oval or circular (Fig. B).

Cash and Hopkinson (1909) described several variations of shape from different samples in Britain, and noted that when the shell had a uniform outline the aperture was often difficult to see.

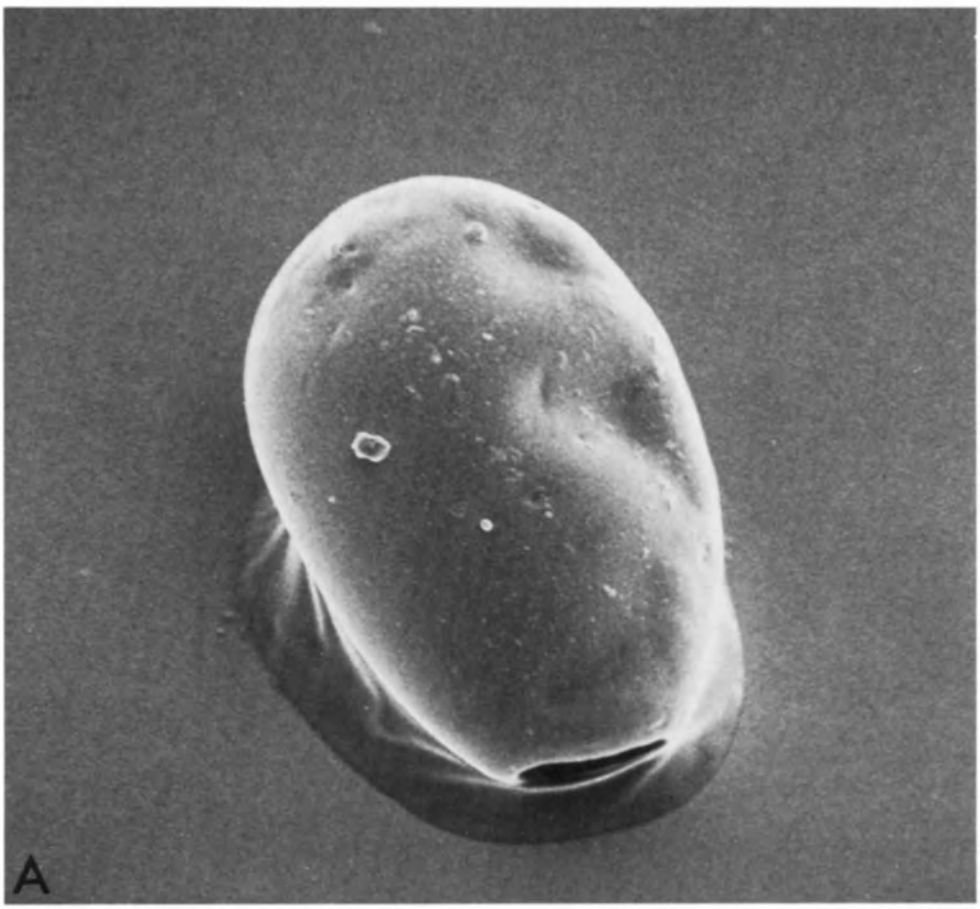
MEASUREMENTS (in μm)

Author	Length of shell	Breadth of shell	Depth of shell	Diameter of aperture
Cash *et al.*, 1909	65–70	45–90	25–26	
Grospietch, 1965	45–87	30–53		
present work n = 2	56–62	37–38	24–25	13–14

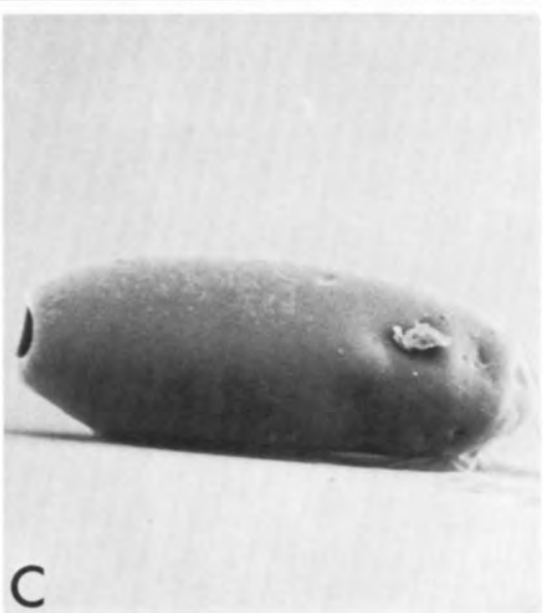
GEOGRAPHICAL DISTRIBUTION Angola, Australia, Brazil, British Isles, Canada, Chile, Colombia, Czechoslovakia, Falkland, I., France, Germany, Java, Netherlands, New Zealand, Seychelles, United States of America.

REFERENCES Bonnet, 1960, 1966, 1967*a*; Grospietch, 1965; Hoogengraad & Groot, 1940*a*, 1940*b*; Jung, 1936*a*, 1936*b*; Lousier, 1976; Puytorac *et al.*, 1972.

Fig. A Broad lateral view × 1350
Fig. B Apertural view × 1250
Fig. C Narrow lateral view × 930


A


B


C

Heleopera petricola Leidy, 1879

DESCRIPTION The shell is brown, purple or violet, ovoid, laterally flattened and composed of siliceous shell plates and some particles of quartz (Figs. A and C). The outline of the shell is smooth and regular, the lateral margins usually being parallel or slightly convex in appearance (Fig. A). The aperture is terminal, slightly convex in broad view, and has an elliptical opening bordered by a thin collar of organic cement (Figs. B and C).

Several forms of this species have been described by Cash *et al.* (1909); Bonnet and Thomas (1955) which differ in size, structure and colour. Cash *et al.* (1909) suggest that variations in this species are such that they all tend to merge into each other.

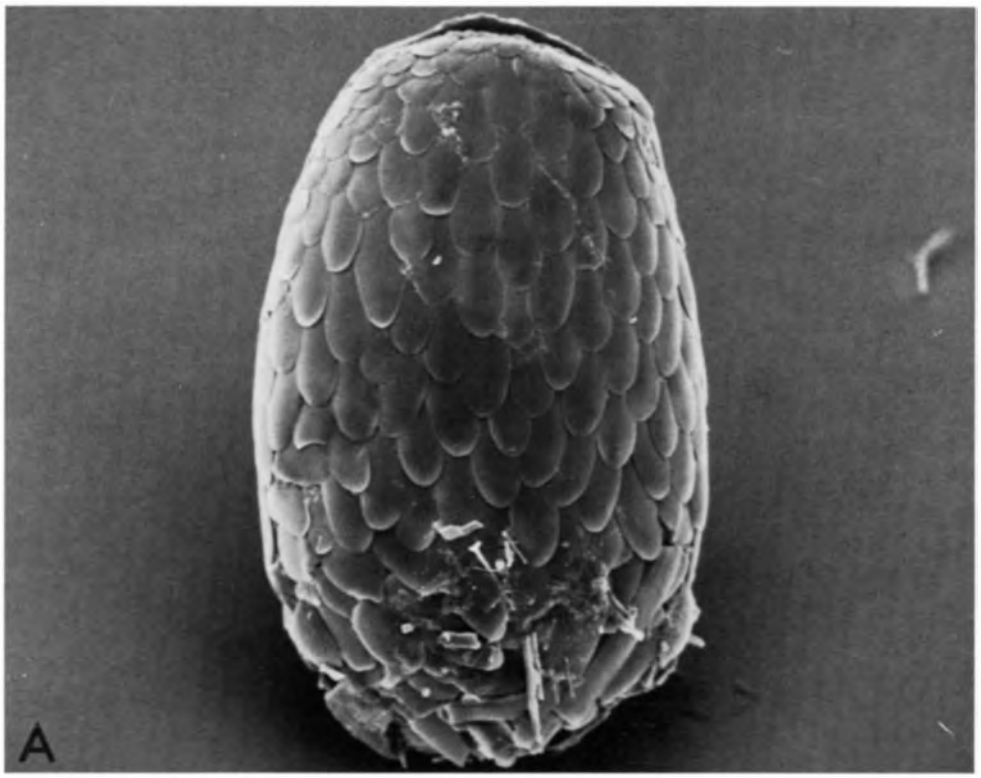
MEASUREMENTS (in μm)

Author	Length of shell	Breadth of shell	Depth of shell	Diameter of aperture
Cash *et al.*, 1909	80–100			
present work n=2	76–84	51–57	40–50	31–34

GEOGRAPHICAL DISTRIBUTION Annobón I., Austria, Belgium, British Isles, Bulgaria, Canada, Chile, Congo, Costa Rica, Faroes, France, Germany, Greece, Guatemala, Iceland, Java, Mexico, Netherlands, New Guinea, Poland, Spain, Spitzbergen, Sweden, Switzerland, United States of America, West Africa.

REFERENCES Bonnet, 1966, 1967*a*, 1967*b*; Chardez, 1961*a*; Decloitre, 1965; Golemansky, 1970, 1974*b*; Graaf, 1956; Gracia, 1963, 1968*a*, 1972; Laminger, 1973*b*, 1975; Lousier, 1976; Hoogenraad & Groot, 1940*a*, 1940*b*, 1946; Jung, 1936*a*; Oye, 1949; Puytorac *et al.*, 1972; Steinecke, 1914; Štěpánek, 1963.

Fig. A Broad lateral view × 1100
Fig. B Apertural view × 1400
Fig. C Narrow lateral view × 1100


A


B


C

Heleopera rosea Penard, 1890

DESCRIPTION The shell is red, ovoid and laterally flattened (Figs. A and B). It is composed mainly of irregularly arranged siliceous shell plates (Fig. D), with only a few quartz particles or diatoms added to the aboral region (Figs. C and E). The aperture is terminal, angular in outline and appears to be a thin, linear slit, bordered by a thin band of organic cement.

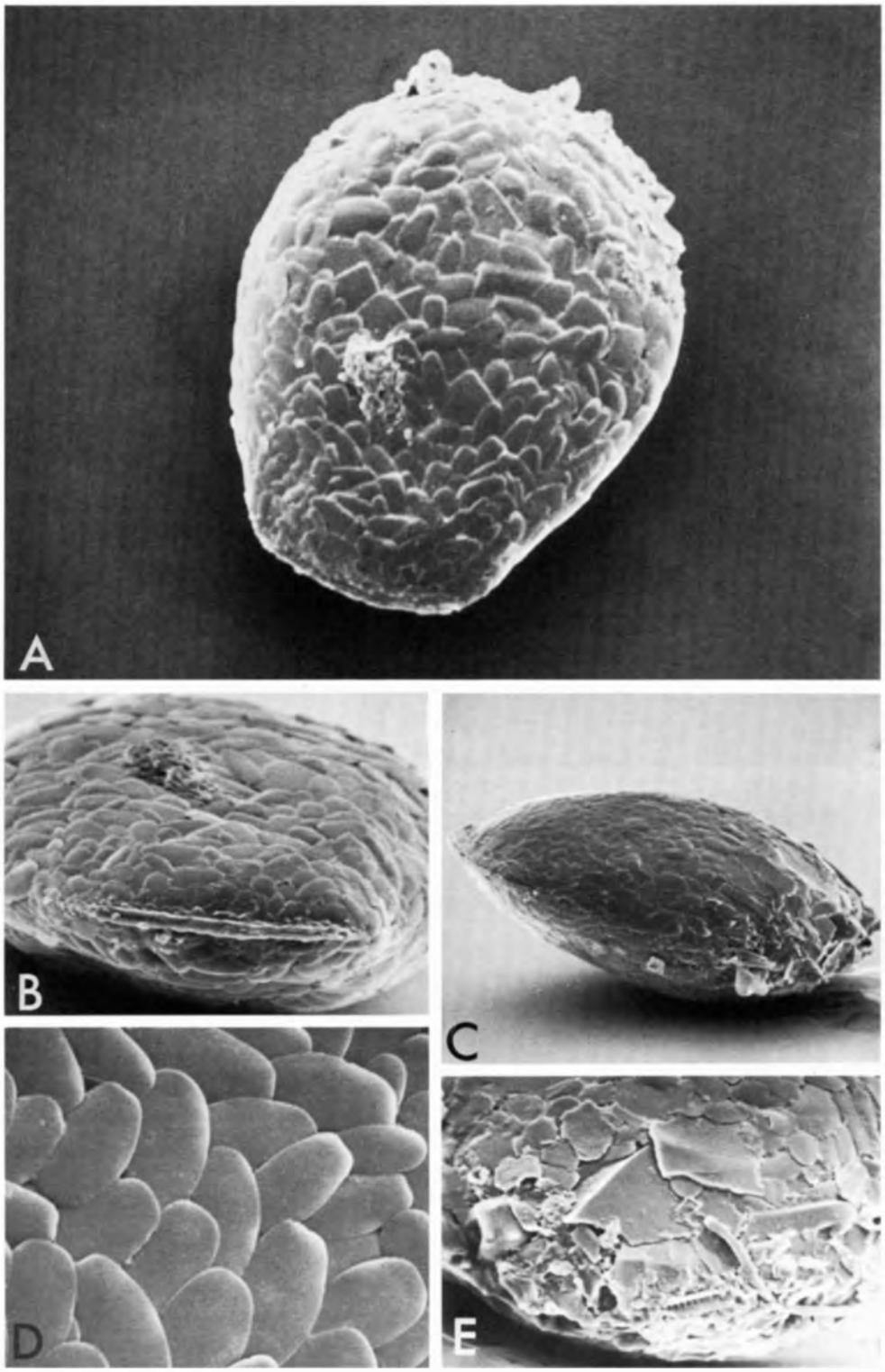
MEASUREMENTS (in μm)

Author	Length of shell	Breadth of shell	Depth of shell	Diameter of aperture
Cash *et al.*, 1909	120–135	90–100		
Bonnet and Thomas, 1960	68–110	43–81		
present work n=7	117–128	94–107	51–57	47–73

GEOGRAPHICAL DISTRIBUTION Annobón I., Austria, Belgium, British Isles, Bulgaria, Canada, Canary I., Chile, France, Germany, Greece, Java, Netherlands, New Guinea, Spain, Sweden, Switzerland, West Africa.

REFERENCES Bonnet, 1966, 1967*a*, 1967*b*; Chardez, 1961*a*; Golemansky, 1974*b*; Gracia, 1963, 1965*b*, 1968*a*, 1972; Grospietch, 1958; Hoogenraad & Groot, 1940*a*, 1940*b*; Jung 1936*a*; Laminger, 1975; MacKinlay, 1936; Puytorac *et al.*, 1972; Schönborn, 1975; Steinecke, 1914.

Fig. A Broad lateral view × 630
Fig. B Apertural view × 780
Fig. C Narrow lateral view × 560
Fig. D Part of shell to illustrate the irregular arrangement of shell plates × 1600
Fig. E Aboral view to show the agglutinated particles of quartz × 810


A
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Heleopera sphangi (Leidy, 1874)

DESCRIPTION The shell is yellow or brown, ovoid and laterally compressed (Fig. A). The sides diverge from the aperture to form a broad semi-circular aboral region, which is rough and composed mainly of sand grains (Figs. A and B). The anterior half of the shell is smooth and composed of siliceous shell plates (Figs. B and D). The aperture is terminal, slightly convex in broad view and is a narrow, linear opening bordered by a thin collar of organic cement (Figs. C and D).

This species varies as much in size and shape as the other species of *Heleopera*, but it can usually be separated from them by the broader and rougher aboral region and the narrow slit-like aperture.

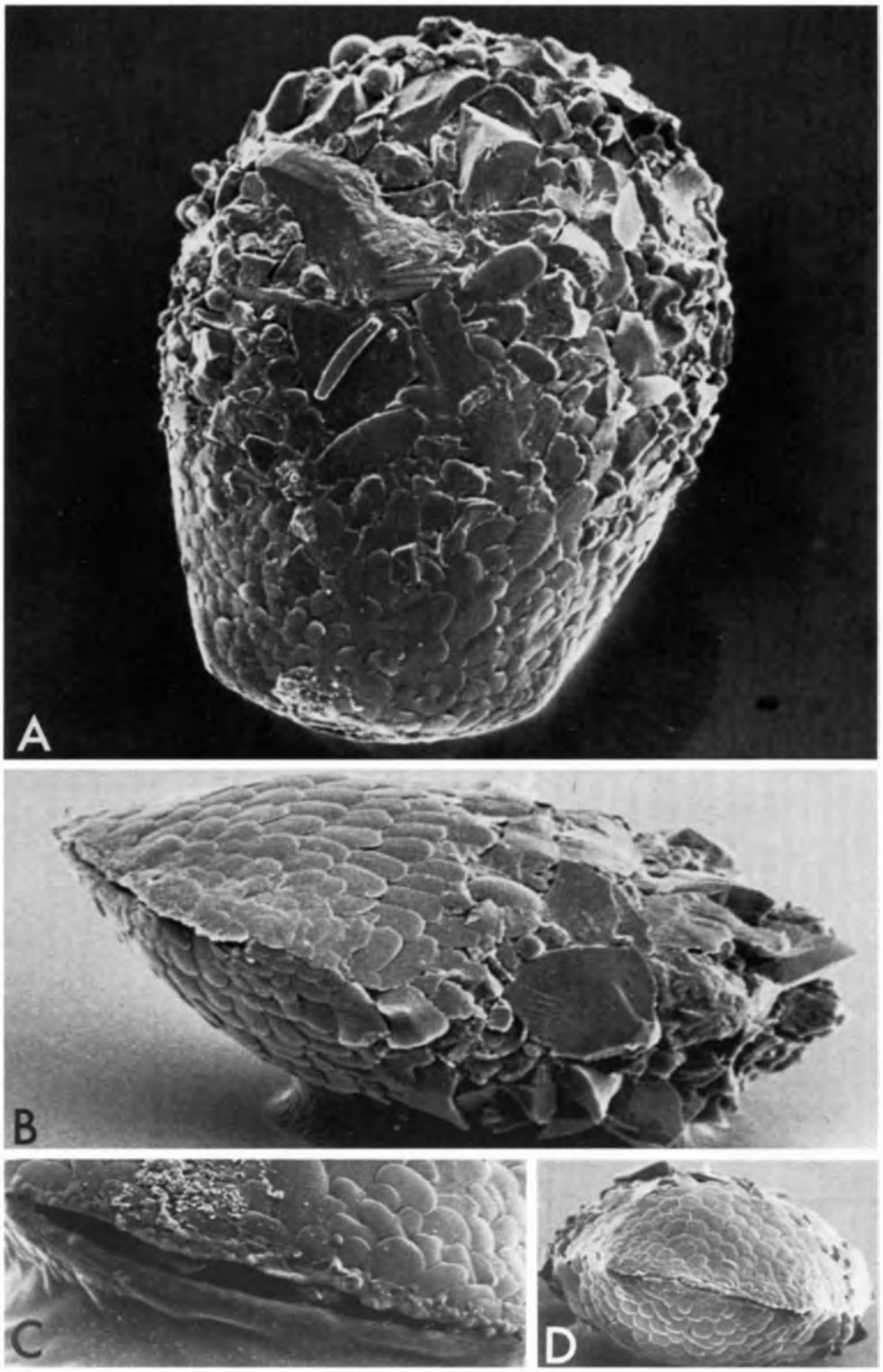
MEASUREMENTS (in μm)

Author	Length of shell	Breadth of shell	Depth of shell	Diameter of aperture
Cash *et al.*, 1909	80–145	50–120		
present work n = 3	94–108	70–73	42–51	40–45

GEOGRAPHICAL DISTRIBUTION Antarctica, Australia, Austria, British Isles, Canada, France, Germany, Mexico, Morocco, Netherlands, South Africa, Spain, Sweden, United States of America.

REFERENCES Decloitre, 1961*a*; Graaf, 1956; Gracia, 1972; Jung, 1936*a*, 1936*b*; Laminger, 1972*a*, 1973*b*, 1975; Schönborn, 1975.

Fig. A Broad lateral view × 1000
Fig. B Narrow lateral view × 1000
Fig. C Detail of aperture to show the narrow slit-like opening × 1500
Fig. D Apertural view × 600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D

Lesquereusia epistomium Penard, 1902

DESCRIPTION The shell colourless, ovoid or circular with a distinct long neck (Fig. A). The neck is joined to the body of the shell at an angle, so that it has one short and one long side (Fig. B). It is composed mainly of curved, siliceous rods and the occasional quartz particle. The aperture is roughly circular and surrounded by siliceous rods (Figs. C and D).

This species is similar to *L. spiralis* but can be differentiated from it by the elongated neck and more circular body.

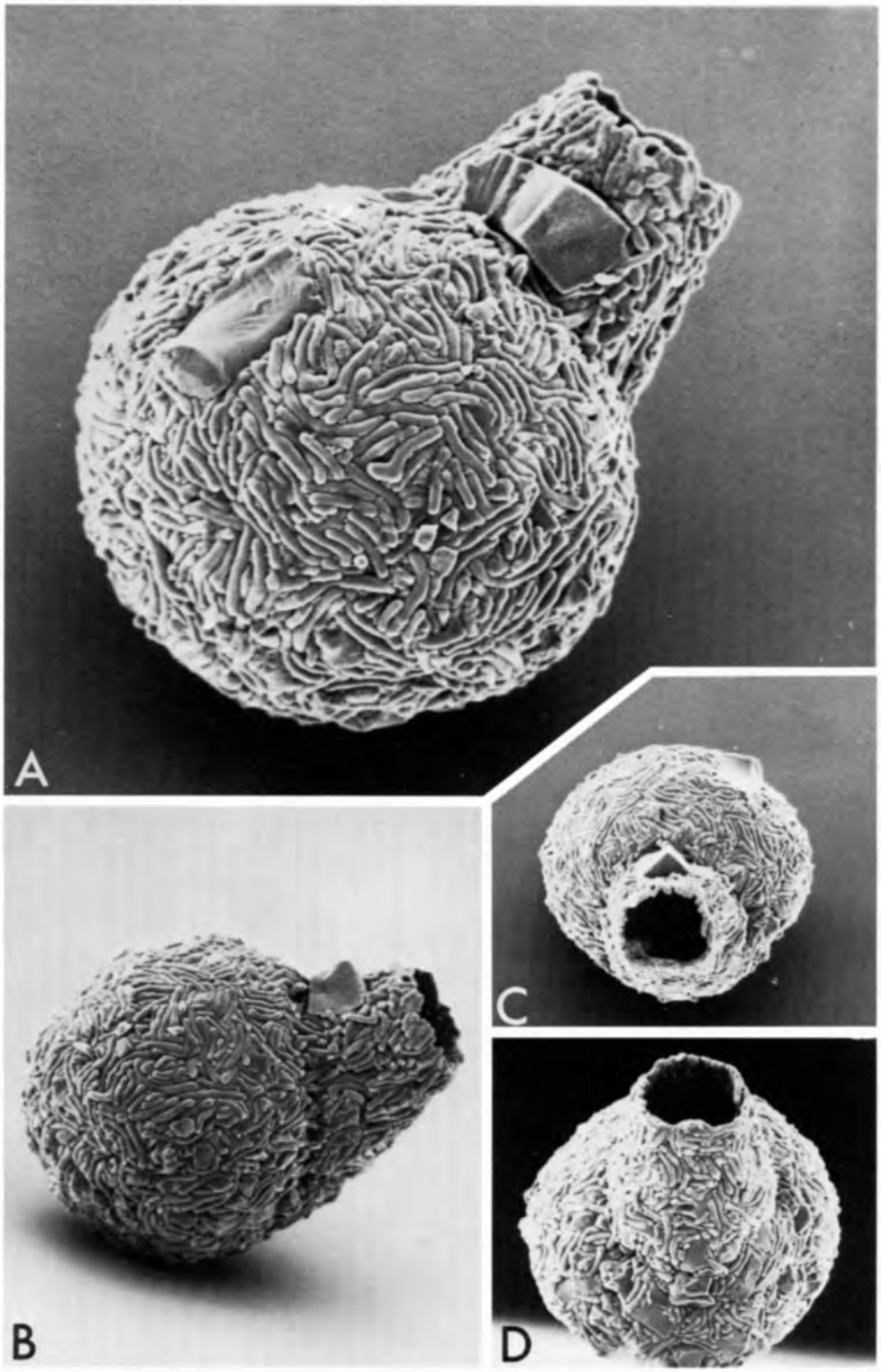
MEASUREMENTS (in μm)

Author	Length of shell	Breadth of shell	Diameter of aperture
Cash *et al.*, 1909	110–125	75–80	
present work n = 1	138	113	36

GEOGRAPHICAL DISTRIBUTION British Isles, Bulgaria, Canada, Czechoslovakia, France, Germany, Iceland, North Africa, Russia, Sweden, Switzerland, United States of America, Venezuela, West Africa.

REFERENCES Decloitre, 1965; Grospietch, 1968*b*, 1975; Puytorac *et al.*, 1972; Schönborn, 1966.

Fig. A Lateral view × 750
Fig. B Latero-apertural view × 400
Fig. C & D Apertural views × 340 & × 390


A
B
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D

Lesquereusia modesta Rhumbler, 1895

DESCRIPTION The shell is colourless, circular with an unsymmetrical neck, and is slightly flattened laterally (Figs. A and C). It is composed of a mixture of siliceous rods and grains of quartz (Figs. A and B). The aperture is terminal, circular and bordered by siliceous rods or small particles of quartz (Fig. D).

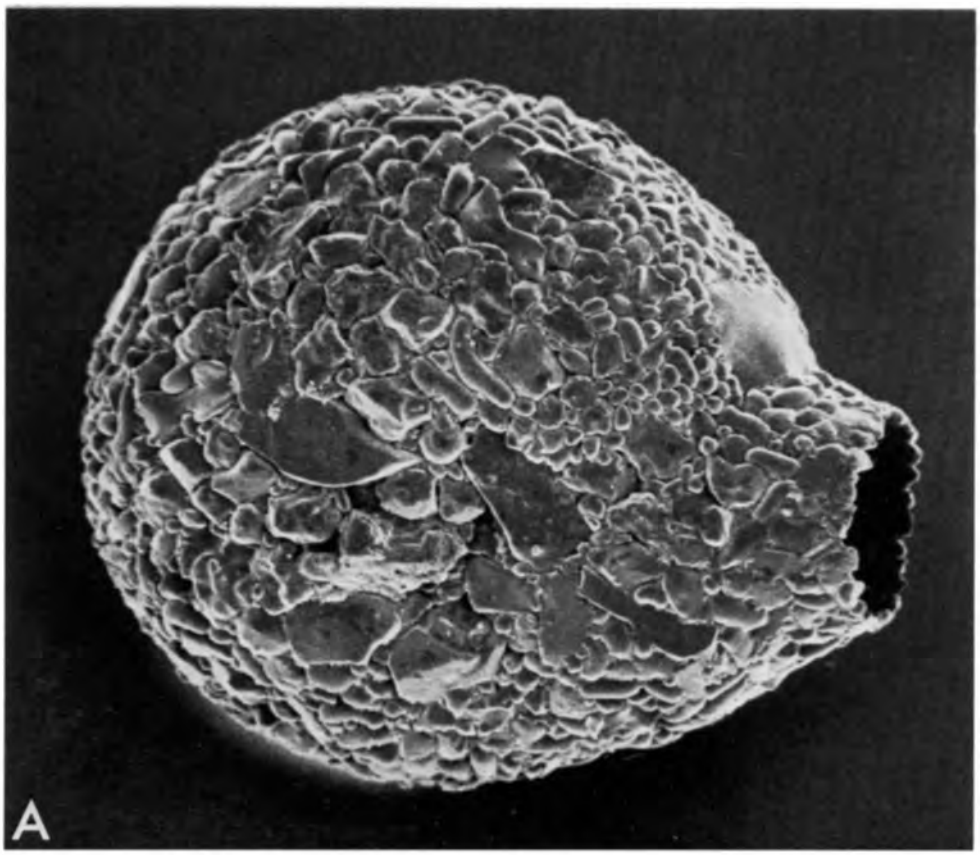
MEASUREMENTS (in μm)

Author	Length of shell	Breadth of shell	Depth of shell	Diameter of aperture
Cash *et al.*, 1909	100	80		
present work n = 22	109–174	100–159	75–112	25–43

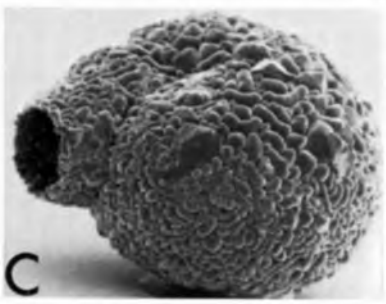
GEOGRAPHICAL DISTRIBUTION Argentina, Austria, Belgium, Brazil, British Isles, Bulgaria, Congo, Czechoslovakia, France, Germany, Mexico, Russia, Sweden, Switzerland, United States of America, Venezuela, West Africa.

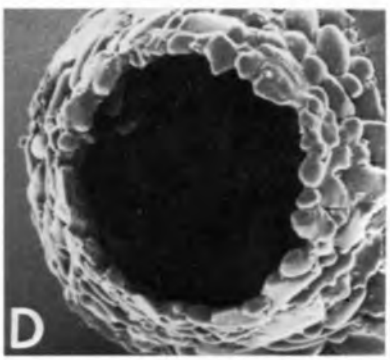
REFERENCES Boltovskoy & Lena, 1966, 1971, 1974; Chardez, 1961*a*; Decloitre, 1948, 1949; Deflandre, 1926; Golemansky, 1974*b*; Green, 1975; Laminger, 1972*c*, 1973*b*; Grospietch, 1958*b*; Schönborn, 1975; Štěpánek, 1963, 1967; Vucetich, 1972.

Fig. A Broad lateral view × 680
Fig. B Portion of shell surface to show the mixture of siliceous rods and particles × 1800
Fig. C Narrow lateral view × 300
Fig. D View of aperture × 850


A


B


C


D

Lesquereusia spiralis (Ehrenberg, 1840)

DESCRIPTION The shell is colourless, circular or ovoid with an unsymmetrical neck, and slightly flattened laterally (Figs. A and B). It is composed of numerous, siliceous curved rods interspersed with a meshwork of organic cement (Fig. C). The organic cement matrix between the rods has a distinctive rosette-like pattern (Fig. E). The aperture is terminal, circular and bordered by siliceous rods (Figs. D).

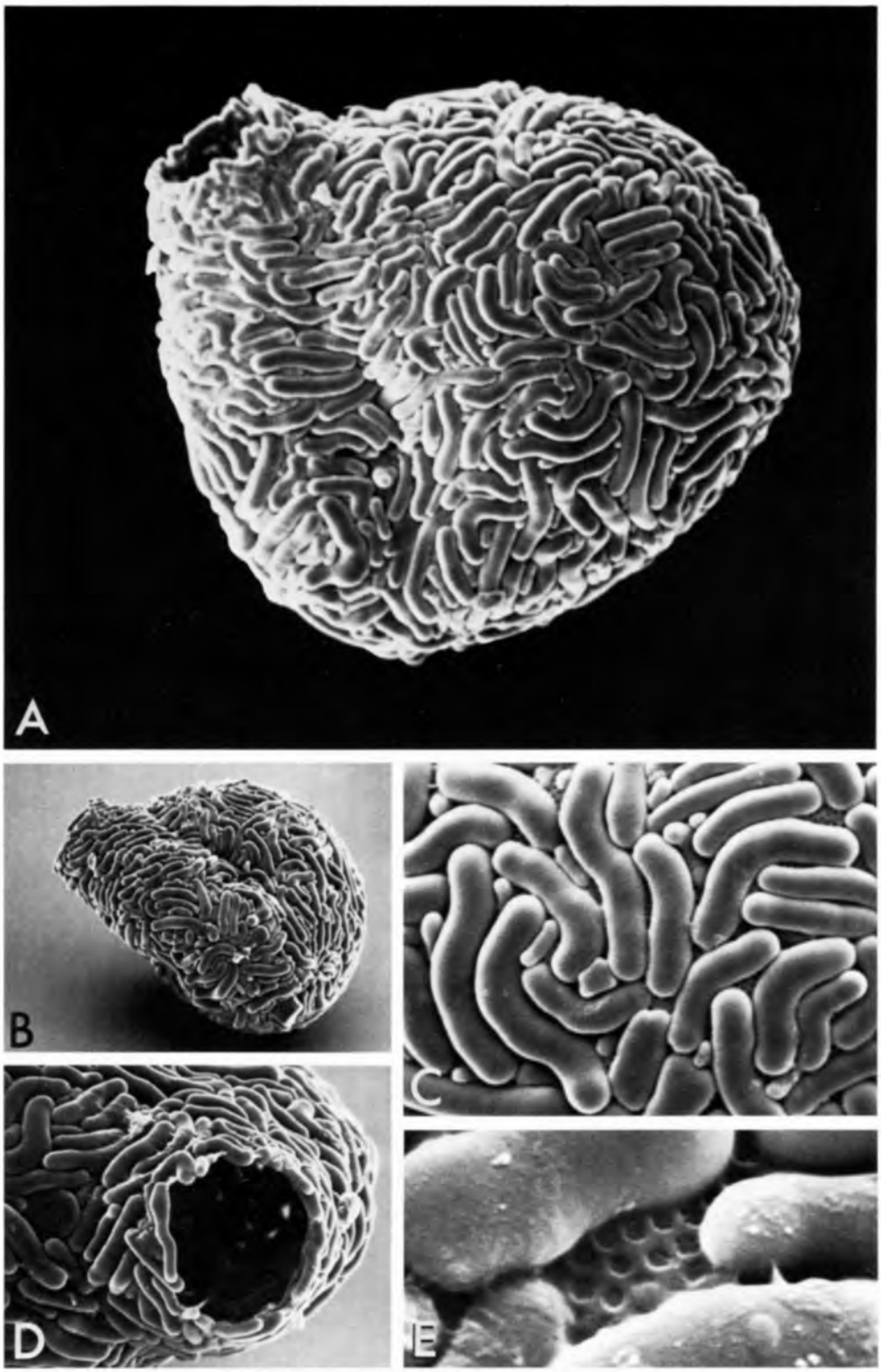
MEASUREMENTS (in μm)

Author	Length of shell	Breadth of shell	Depth of shell	Diameter of aperture
Cash *et al.*, 1909	120	95		
present work n=8	89–117	86–109	62–84	23–31

GEOGRAPHICAL DISTRIBUTION Australia, Belgium, Brazil, British Isles, Canada, Congo, France, Germany, Netherlands, Roumania, Russia, South Africa, Sweden, Switzerland, United States of America, Venezuela, West Africa.

REFERENCES Chardez, 1961*a*; Decloitre, 1947, 1948; Deflandre, 1926; Godenau *et al.*, 1973; Graaf, 1956; Grospietch, 1958*b*; Laminger, 1972*a*; Playfair, 1918; Puytorac *et al.*, 1972; Schönborn, 1975; Štěpánek, 1963.

Fig. A Broad lateral view × 920
Fig. B Narrow lateral view × 460
Fig. C Part of surface to show the arrangement of the siliceous rods × 1750
Fig. D Apertural view × 1100
Fig. E Detail of organic matrix to illustrate the rosette-like pattern × 9200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Nebela barbata Leidy, 1874

DESCRIPTION The shell is colourless and pyriform with an elongated neck (Figs. A and D). It is composed of a mixture of oval, circular and elongate shell plates, with numerous short, fine spines projecting from the junctions of the shell plates (Fig. C). The spines are often flattened against the shell and difficult to see. The aperture is oval and surrounded by a collar of organic cement, the inner margin of which has about eight tooth-like protrusions (Fig. B).

Cash (1909) noted that the spines were seldom seen on specimens from Britain. From our observations we suggest that this was due mainly to their fragility, as they are easily lost in handling. The tooth-like protrusions were absent in one of our specimens so this may be a variable character.

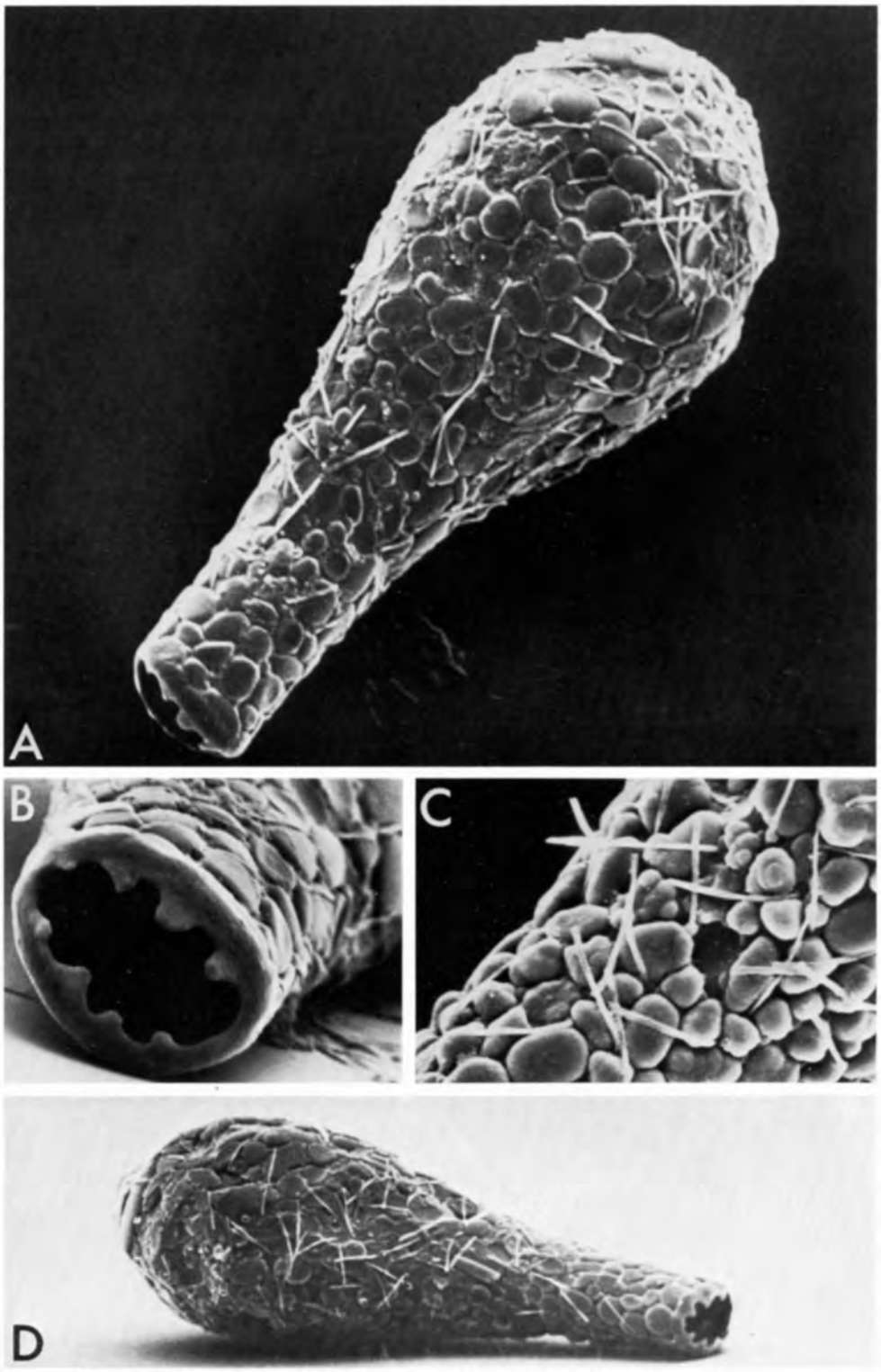
MEASUREMENTS (in μm)

Author	Length of shell	Breadth of shell	Depth of shell	Diameter of aperture
Cash *et al.*, 1909	80–160	40–60		
de Graaf, 1956	120–148	40–62		20–23
present work n = 5	96–106	38–44	36–41	10–16

GEOGRAPHICAL DISTRIBUTION British Isles, Congo, Finland, France, Germany, Java, Netherlands, Russia, Spitzbergen, United States of America.

REFERENCES Decloitre, 1965; Deflandre, 1936; Graaf, 1956; Hoogenraad & Groot, 1946.

Fig. A Lateral view × 1100
Fig. B View of aperture to show the tooth-like protrusions × 2000
Fig. C Portion of shell with spines × 2300
Fig. D Latero-apertural view × 760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Nebela bigibossa Penard, 1890

DESCRIPTION The shell is yellow, pyriform and laterally compressed (Figs. A and C). At approximately one third of the body length from the aperture, on each side, are distinct lateral depressions with large central pores (Figs. A, C and D). Viewed laterally the shell appears to be pinched in the region of the depressions, and a small lateral pore is present just anterior to the larger pores (Figs. C and D). It is composed of oval, circular and elongate shell plates (Fig. B). The aperture is oval, convex in outline, and surrounded by a distinct organic collar (Figs. A and D).

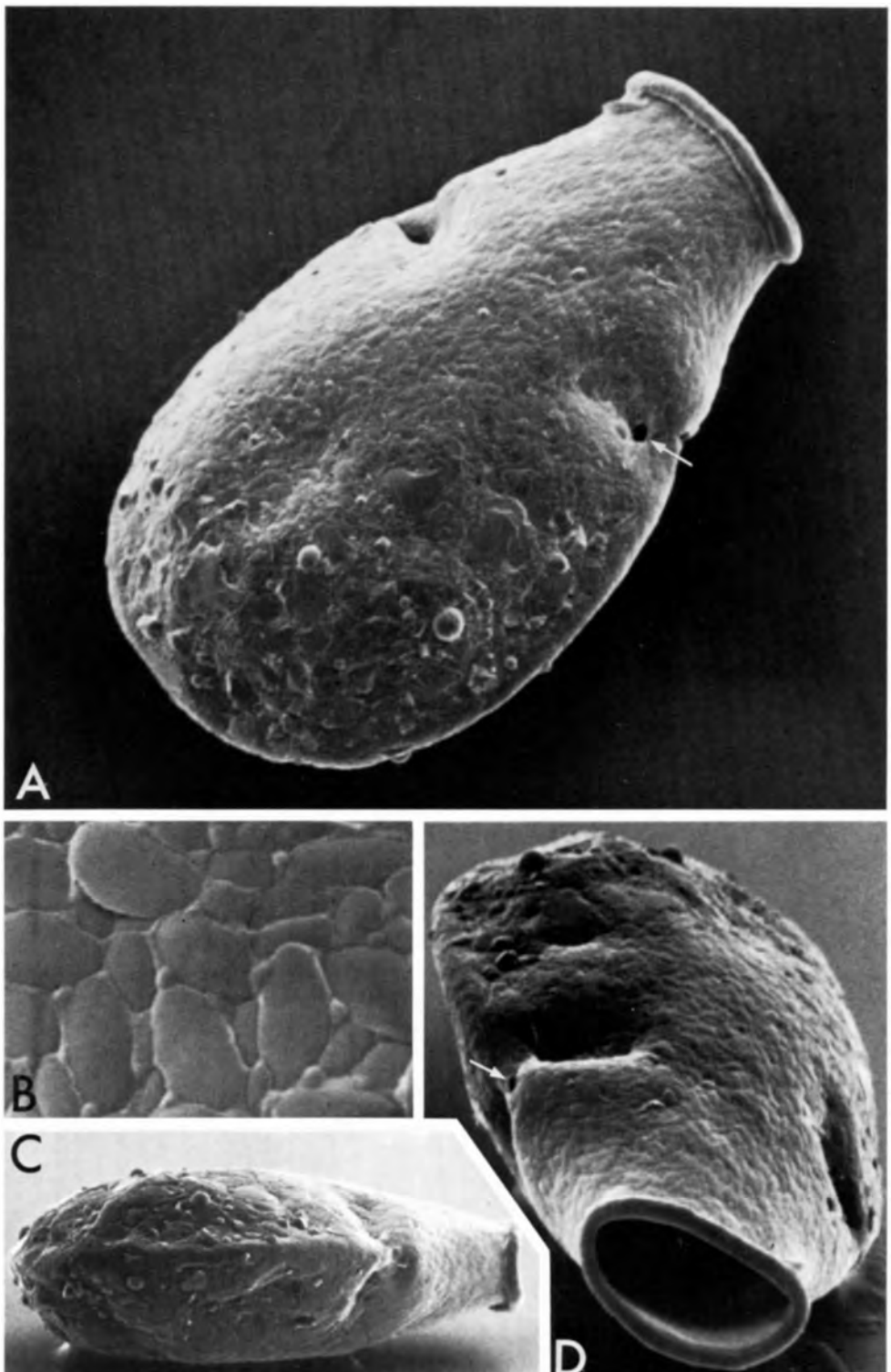
MEASUREMENTS (in μm)

Author	Length of shell	Breadth of shell	Depth of shell	Diameter of aperture
Cash *et al.*, 1919	135–170	87–110	50–55	34–45
present work n=2	153–171	95–115	55–56	38–41

GEOGRAPHICAL DISTRIBUTION British Isles, Canada, Chile, France, Germany, Greece, Java, Switzerland.

REFERENCES Bonnet, 1966, 1967*b*; Deflandre, 1936; Hoogenraad & Groot, 1940*a*; Puytorac *et al.*, 1972.

Fig. A Broad lateral view, note the large pore in the lateral depression (arrowed) × 700
Fig. B Portion of shell with overlapping shell plates × 4700
Fig. C Narrow lateral view × 450
Fig. D Apertural view to show the lateral depressions and small lateral pore (arrowed) × 710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Nebela carinata (Archer, 1867)

DESCRIPTION The shell is colourless, oval or pyriform with a lateral ridge that begins just posterior to the aperture (Fig. A), laterally compressed (Fig. C) with a small lateral pore present on each side. It is composed mainly of oval or circular shell plates, often interspersed with small beads of organic cement (Fig. D). The aperture is oval and surrounded by a thin collar of organic cement (Fig. B).

The most distinctive feature of this species is the lateral ridge. But as Cash *et al.*, (1909) noted, the degree of development of this feature is not constant and they suggested that this probably indicated a wide range of variability.

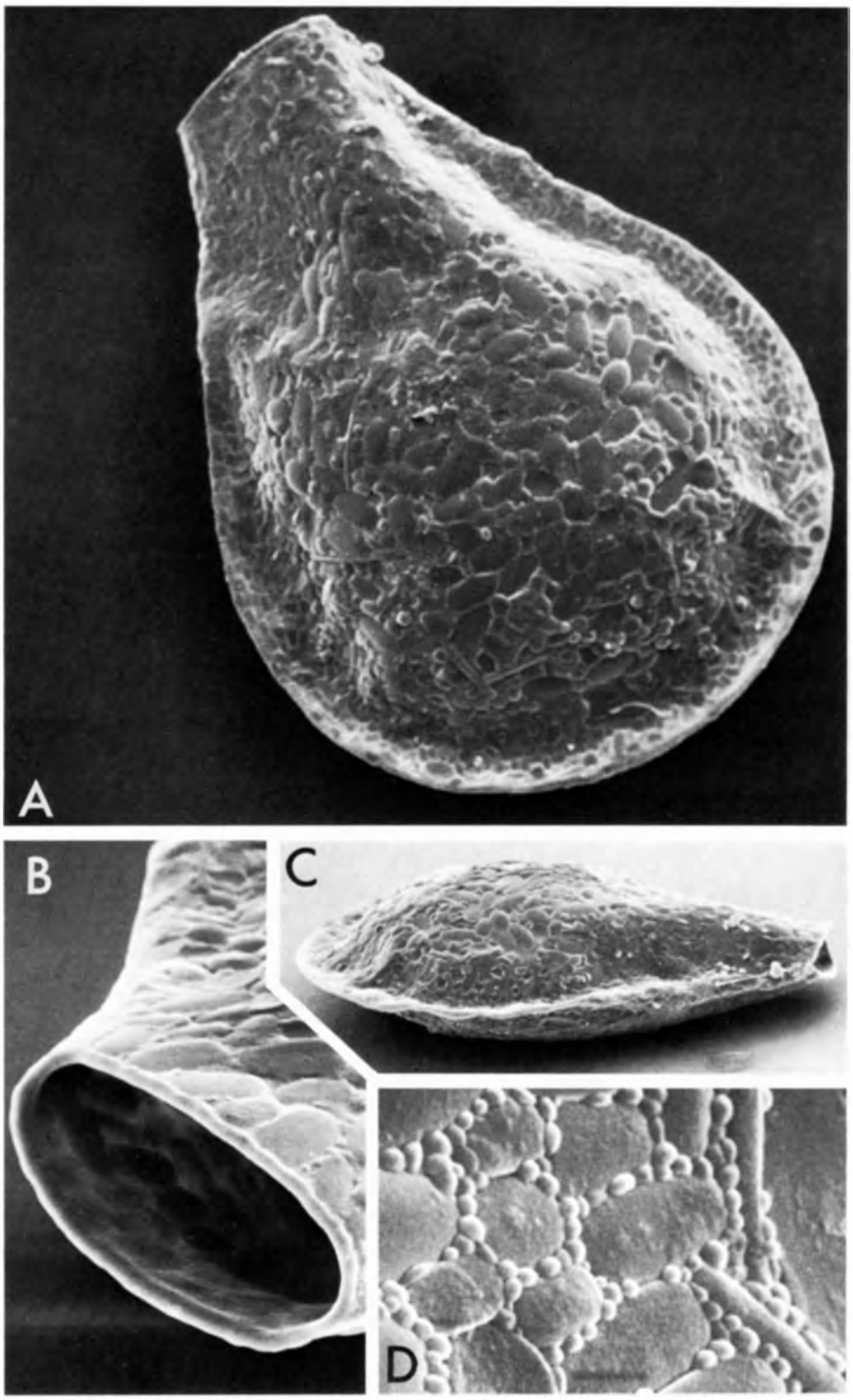
MEASUREMENTS (in μm)

Author	Length of shell	Breadth of shell	Depth of shell	Diameter of aperture
Cash *et al.*, 1909	140–180	110–130		
present work n = 12	155–202	110–152	55–66	27–43

GEOGRAPHICAL DISTRIBUTION Austria, Belgium, British Isles, Canada, Congo, France, Germany, Spain, Switzerland, United States of America.

REFERENCES Chardez, 1961*a*; Deflandre, 1936; Gauthier-Lièvre, 1954; Gracia, 1968*b*, 1972; Grospietch, 1958; Jung, 1936*b*; Laminger, 1975; Puytorac *et al.*, 1972.

Fig. A Broad lateral view × 660
Fig. B View of aperture × 1500
Fig. C Narrow lateral view × 390
Fig. D Shell plates interspersed with small beads of organic cement × 4100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Nebela collaris (Ehrenberg, 1848)

DESCRIPTION The shell is colourless, ovoid, slightly compressed laterally with a small lateral pore on each side (Figs. A, C and E). It is composed mainly of oval or circular shell plates arranged in a regular manner so that they do not overlap. The aperture is oval and has a thin organic collar (Figs. B and D).

The formation of the shell of *N. collaris* has been described by MacKinley (1936) who noted that in the absence of other smaller testate amoebae as a source of food, the shell wall consisted of a membrane devoid of shell plates. Heal (1963) examined the morphological variation of specimens belonging to the *Nebela tincta-collaris-bohemica* group and concluded that although *N. tincta* could be distinguished as a valid species, he could not separate *N. bohemica* and *N. collaris*.

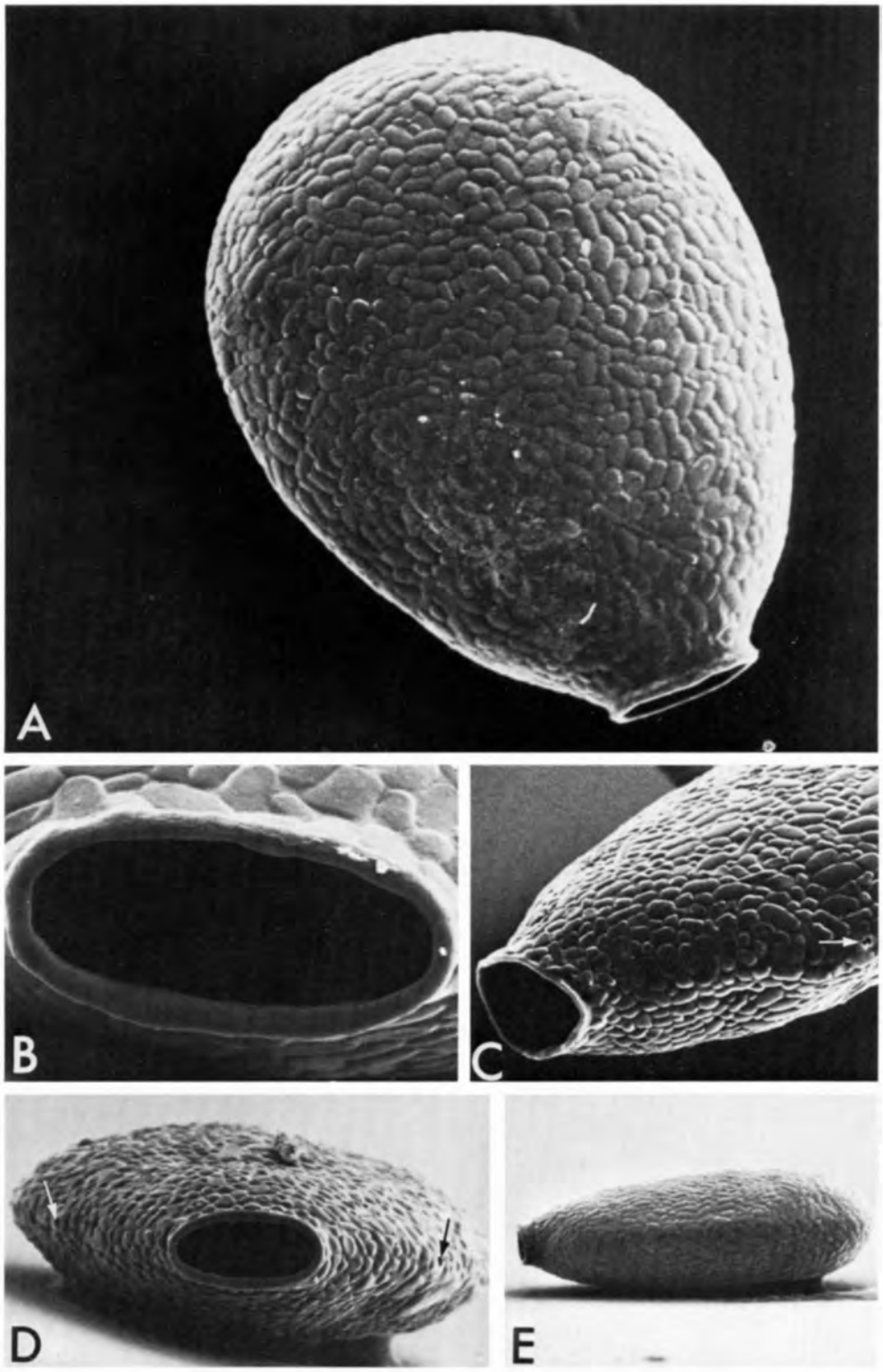
MEASUREMENTS (in μm)

Author	Length of shell	Breadth of shell	Depth of shell	Diameter of aperture
Deflandre, 1936	115–130	65–80		25–32
de Graaf, 1956	93–128	62–100		23–35
present work n=25	98–153	72–91	33–42	24–35

GEOGRAPHICAL DISTRIBUTION Annobón I., Austria, Canada, Canary I., Congo, Costa Rica, Faroes, France, Germany, Greece, Greenland, Guatemala, Iceland, Italy, Java, Mexico, Netherlands, New Guinea, North Africa, Seychelles, Spain, Spitzbergen, Sweden, Switzerland, United States of America, West Africa.

REFERENCES Bonnet, 1967*a*, 1967*b*; Decloitre, 1965; Deflandre, 1936; Gauthier-Lièvre, 1965; Golemansky, 1974*b*; Graaf, 1956; Gracia, 1963, 1968*a*, 1972; Grospietch, 1958*a*; Heal, 1963*b*; Hoogenraad & Groot, 1940*a*, 1940*b*, 1946; Laminger, 1973*b*, 1975; Lousier, 1976; MacKinlay, 1936; Oye, 1949; Rampi, 1947; Schönborn, 1975; Steinecke, 1914; Štěpánek, 1963.

Fig. A Broad lateral view × 920
Fig. B View of aperture × 1900
Fig. C View to show lateral pore (arrowed) × 800
Fig. D Apertural view, note the position of the lateral pores (arrowed) × 820
Fig. E Narrow lateral view × 420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Nebela dentistoma Penard, 1890

DESCRIPTION The shell is colourless, ovoid, slightly compressed laterally and composed of oval, and elongate shell plates (Figs. A, B and D). The shell plates do not overlap and the organic cement between the plates appears to be porous (Fig. C). The aperture is oval and surrounded by shell-plates (Fig. E).

Cash *et al.* (1909) stated that the shell of this species fractured when subjected to pressure, whereas those of *N collaris* and *N. tincta* were simply distorted. We agree with this and suggest that the shell of *N. dentistoma* is of a more rigid construction. Three varieties of this species are described by Deflandre (1936) in his review of the genus which differ in size and shape of the aperture and shell.

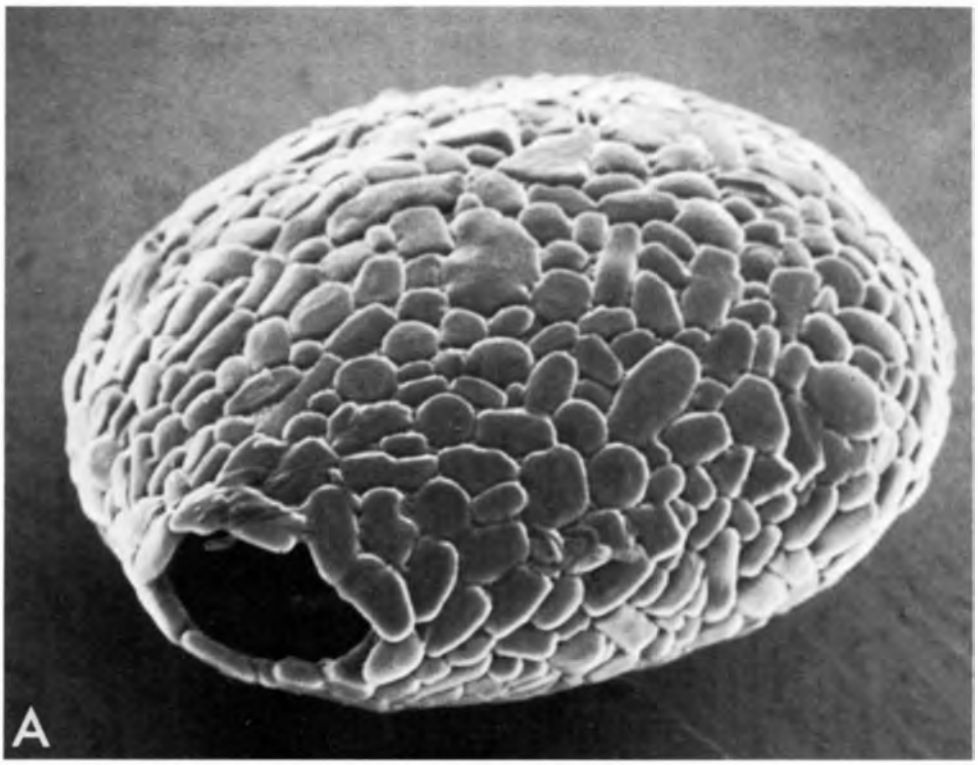
MEASUREMENTS (in μm)

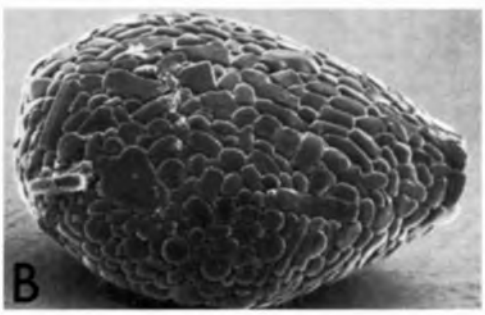
Author	Length of shell	Breadth of shell	Depth of shell	Diameter of aperture
Cash *et al.*, 1909	95–115	73–90		
present work n = 11	81–96	58–80	40–59	14–26

GEOGRAPHICAL DISTRIBUTION Antarctica, Australia, Belgium, British Isles, Bulgaria, Canada, Chile, Colombia, Congo, Costa Rica, Czechoslovakia, France, Germany, Greenland, Guatemala, Iceland, Japan, Java, Kenya, Marion I., Mexico, Netherlands, New Zealand, Spain, Switzerland, United States of America, Venezuela, West Africa.

REFERENCES Bonnet, 1966, 1967*a*; Decloitre, 1948, 1949, 1954, 1955, 1965; Deflandre, 1936; Gauthier-Lièvre, 1954; Golemansky, 1974*b*; Graaf, 1956; Gracia, 1972; Grospietch, 1958*a*, 1971; Hoogenraad & Groot, 1940*a*, 1940*b*, 1946, 1948; Laminger, 1973*b*; Lousier, 1976; Oye, 1949; Puytorac *et al.*, 1972; Štěpánek, 1963.

Fig. A Latero-apertural view × 1300
Fig. B Narrow lateral view × 610
Fig. C View of shell-plates to illustrate the porous organic cement × 4900
Fig. D Broad lateral view × 580
Fig. E View of aperture to show the surrounding shell plates × 1700


A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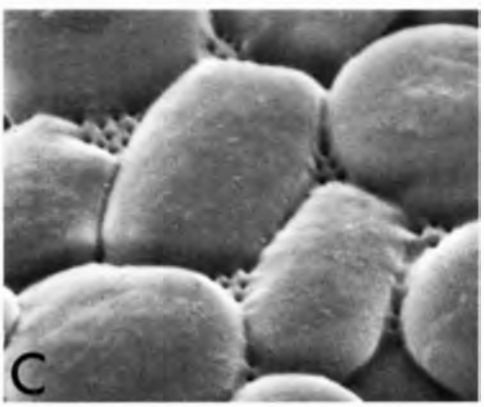
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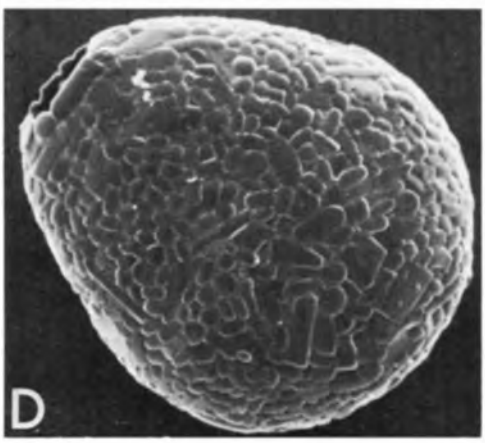
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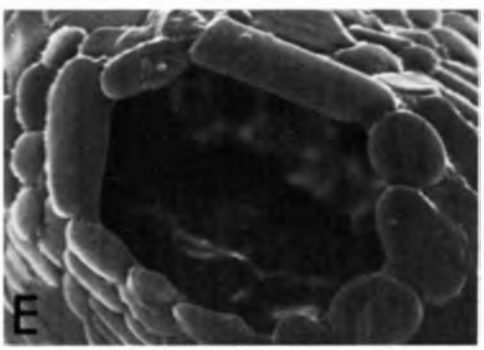

E

Nebela flabellulum Leidy, 1874

DESCRIPTION The shell is colourless, circular or ovoid with a short neck (Fig. A), and a small lateral pore on each side (Fig. C). It is laterally compressed and composed mainly of oval or circular shell plates, smaller shell plates or beads of cement are often seen between the larger shell plates (Figs. B and C). The shell plates sometimes appear to be covered with a thin layer of cement so that the edges are not clearly defined. The aperture is oval and surrounded by a collar of organic cement (Figs. C and D).

This species can be distinguished from *N. collaris* and *N. tincta* which it closely resembles, by being wider in size than it is long.

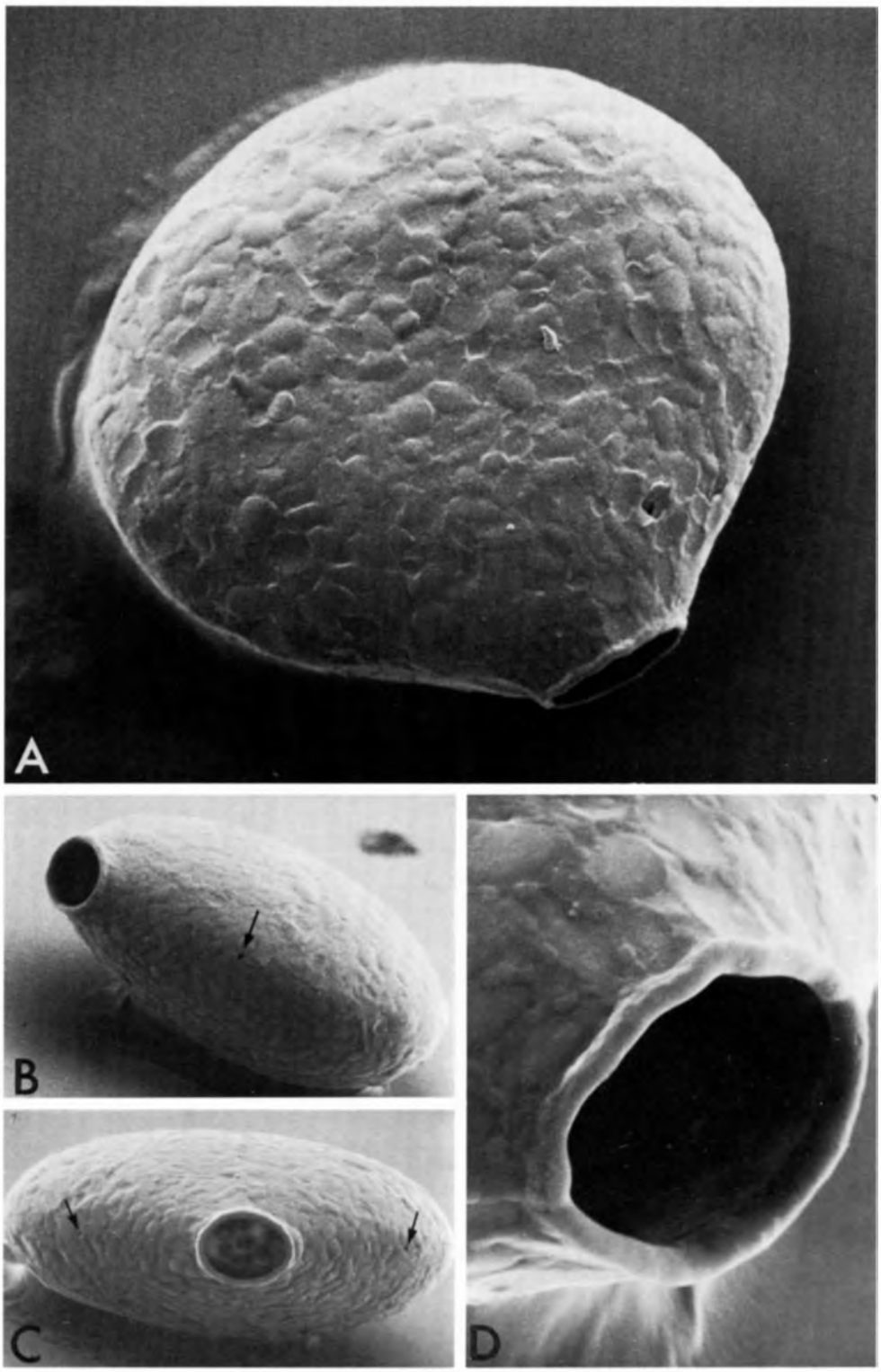
MEASUREMENTS (in μm)

Author	Length of shell	Breadth of shell	Depth of shell	Diameter of aperture
Cash *et al.*, 1909	80–90	90–110		
Deflandre, 1936	72–96	90–110		19–30
present work n=9	76–88	86–95	35–41	18–25

GEOGRAPHICAL DISTRIBUTION Austria, Belgium, British Isles, Canada, France, Germany, Switzerland, United States of America.

REFERENCES Chardez, 1961*a*; Deflandre, 1936; Heal, 1963*b*; Jung, 1936*a*; Laminger, 1975.

Fig. A Broad lateral view × 920
Fig. B Narrow lateral view, with lateral pore (arrowed) × 600
Fig. C Apertural view to illustrate both lateral pores (arrowed) × 650
Fig. D View of aperture to show apertural collar × 2600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Nebela galeata Penard, 1890

DESCRIPTION The shell is colourless, pyriform with a distinct thickened lateral margin (Figs. A and B). A small lateral pore is present on each side, often at the point of origin of the lateral margins (Fig. B). It is composed mainly of oval or siliceous shell plates, occasionally interspersed with smaller shell plates or beads of organic cement (Fig. D). The aperture is oval and usually has a thin organic collar (Fig. C).

Nebela galeata is similar to *N. carinata* and *N. marginata* in having a lateral margin, but in the two latter species the margin is thin and sharply-pointed. Deflandre (1936) described a new variety of this species, *N. g.* var. *orbicularis*, which has a reduced margin and is oval or circular in shape.

MEASUREMENTS (in μm)

Author	Length of shell	Breadth of shell	Depth of shell	Diameter of aperture
Cash *et al.*, 1909	180–200	100		
Deflandre, 1936	180–200	94–114		31–40
present work n=7	190–283	113–153	42–100	26–51

GEOGRAPHICAL DISTRIBUTION Belgium, British Isles, France, Germany, Java, Netherlands, Sweden, Switzerland, United States of America.

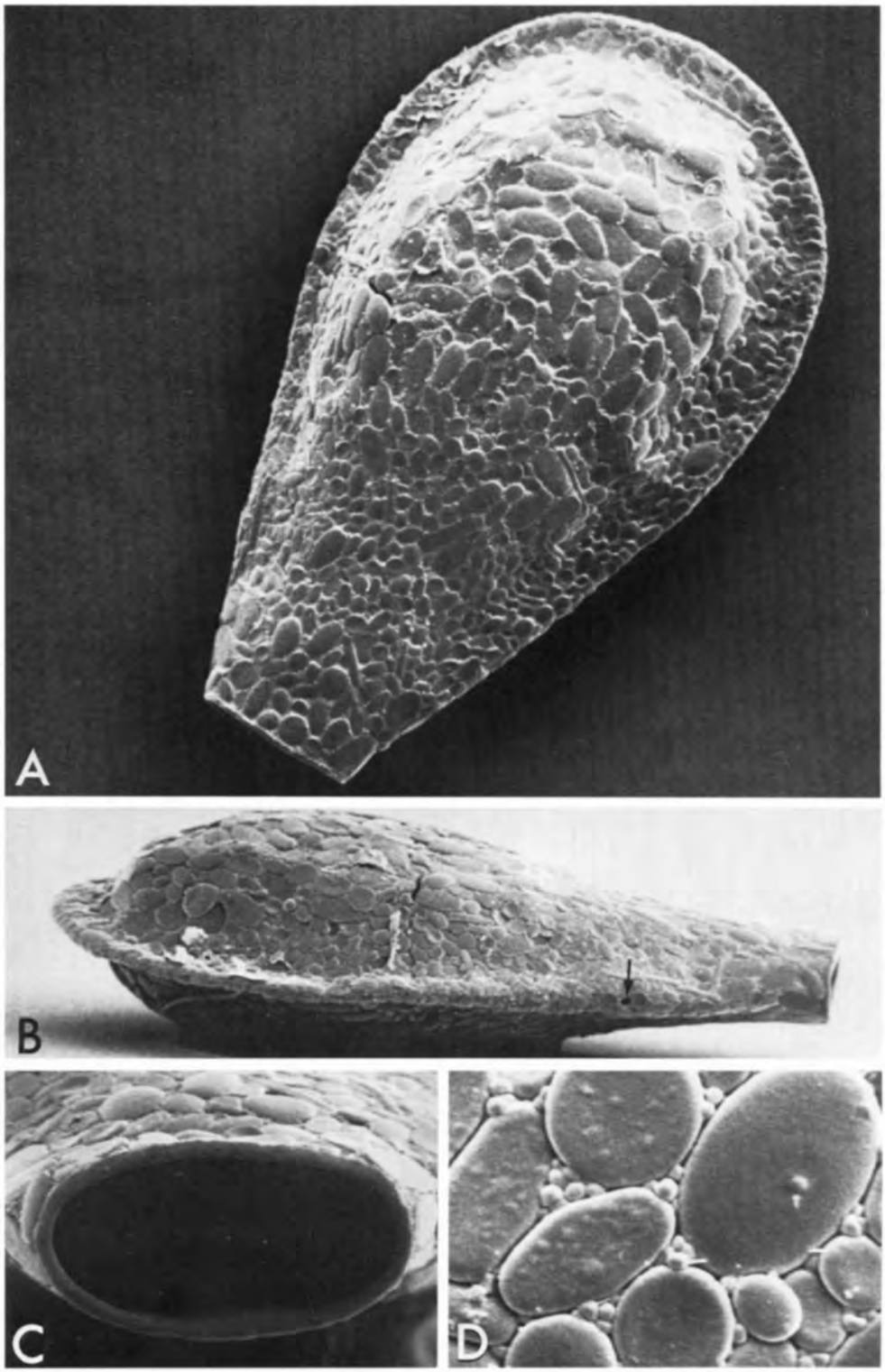
REFERENCES Chardez, 1961*a*; Deflandre, 1936; Grospietch, 1958*b*; Hoogenraad & Groot, 1940*b*, 1946; Schönborn, 1975.

Fig. A Broad lateral view × 550

Fig. B Narrow lateral view, note the thick lateral margin and lateral pore (arrowed) × 510

Fig. C View of aperture × 1400

Fig. D Portion of surface showing the arrangement of the shell plates × 3300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Nebela griseola Penard, 1911

DESCRIPTION The shell is yellow or brown, pyriform and slightly compressed laterally (Figs. A and B). It is composed of siliceous shell plates and pieces of quartz, arranged in a random manner to give an uneven appearance (Figs. A and C). The aperture is circular and bordered by a prominent collar of mainly circular shell plates (Figs. A and D).

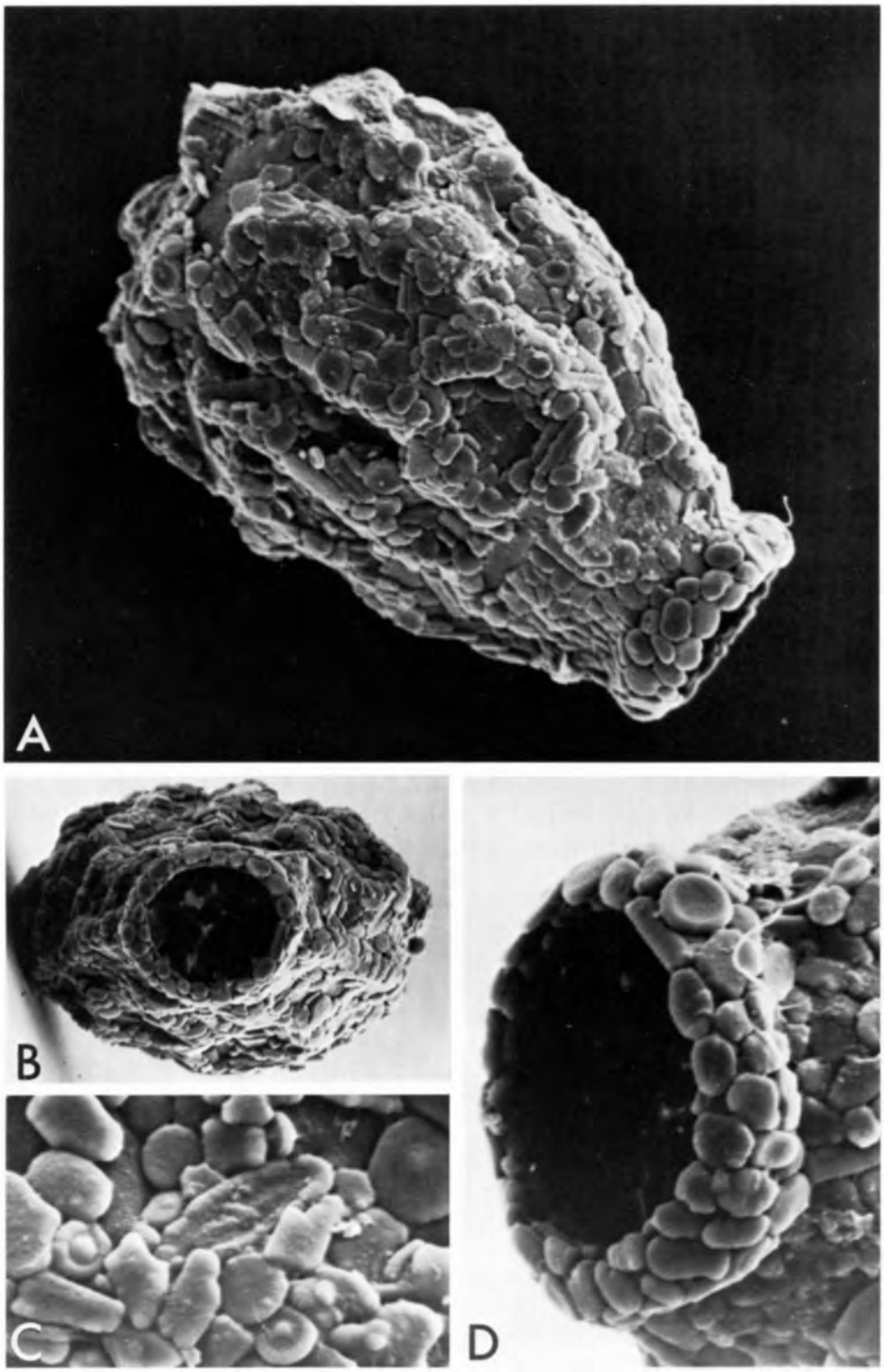
MEASUREMENTS (in μm)

Author	Length of shell	Breadth of shell	Depth of shell	Diameter of shell
Cash *et al.*, 1919	80–87	52–60	45–55	18–23
present work n=2	82–88	62–69	50–51	20–21

GEOGRAPHICAL DISTRIBUTION Antarctica, Australia, British Isles, Canada, France, Germany, Java, Netherlands, Switzerland.

REFERENCES Deflandre, 1936; Graaf, 1956; Grospietch, 1958; Hoogenraad & Groot, 1940*a*, 1946; Puytorac *et al.*, 1972; Steineke, 1914.

Fig. A Lateral view × 1350
Fig. B Apertural view × 890
Fig. C Portion of shell × 3100
Fig. D Lateral view of aperture × 2300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Nebela militaris Penard, 1890

DESCRIPTION The shell is colourless, ovoid or pyriform with a convex aperture in broad view (Fig. A). It is slightly compressed laterally, has small lateral pores, and is composed of a mixture of oval, circular and rectangular shell plates (Fig. B). The aperture is an elongate slit, which is concave when viewed laterally, and surrounded by a thick organic collar (Figs. C and D).

Cash (1909) described some specimens that were broader than average, but suggests that this appears to be the only variation.

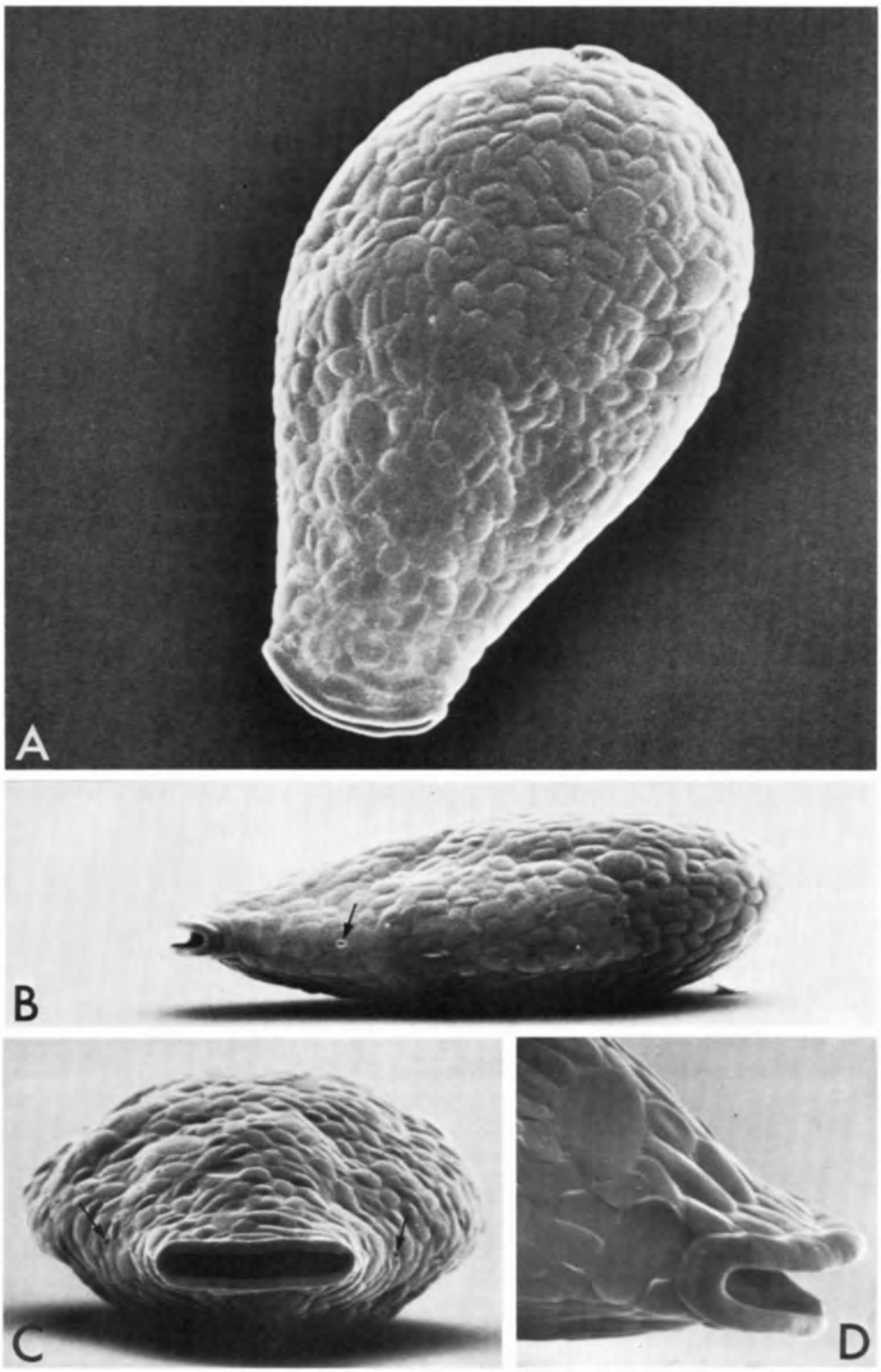
MEASUREMENTS (in μm)

Author	Length of shell	Breadth of shell	Depth of shell	Diameter of aperture
Cash *et al.*, 1909	50–70	25–35		
Deflandre, 1936	50–72	25–38		16–20
present work n=4	59–70	33–41	21–23	15–18

GEOGRAPHICAL DISTRIBUTION Angola, Austria, Belgium, British Isles, Canada, Congo, France, Germany, Java, Netherlands, Poland, Spain, Switzerland, Tunisia.

REFERENCES Bonnet, 1960; Chardez, 1961*a*; Deflandre, 1936; Gauthier-Lièvre, 1954; Golemansky, 1973; Graaf, 1956; Gracia, 1972; Grospietch, 1958*a*; Haeck, 1956; Heal, 1963*b*; Hoogenraad & Groot, 1940*a*, 1940*b*, 1946; Jung, 1936*b*; Laminger, 1972*a*; Puytorac *et al.*, 1972; Steinecke, 1914.

Fig. A Broad lateral view × 1600
Fig. B Narrow lateral view to illustrate the position of the lateral pore (arrowed) × 1200
Fig. C Apertural view, note position of lateral pores (arrowed) × 1500
Fig. D Lateral view of aperture to show the organic collar × 3600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Nebela penardiana Deflandre, 1936

DESCRIPTION The shell is brown, pyriform or elongate, slightly compressed laterally and has small lateral margins (Figs. A and D). The lateral margins do not extend around the aboral region, but small lateral pores are usually present at a distance of one-third of the body length from the aperture. It is composed of a mixture of oval, circular and quadrangular shell plates (Fig. C). The aperture is oval, sometimes concave from a lateral aspect, and surrounded by a collar of organic cement (Fig. B).

This species is easily distinguished from *N. marginata* by being narrower and having less pronounced lateral margins, and from *N. tubulosa* in size and shape. One variety of *N. penardiana* is noted by Deflandre (1936) in his review of the genus.

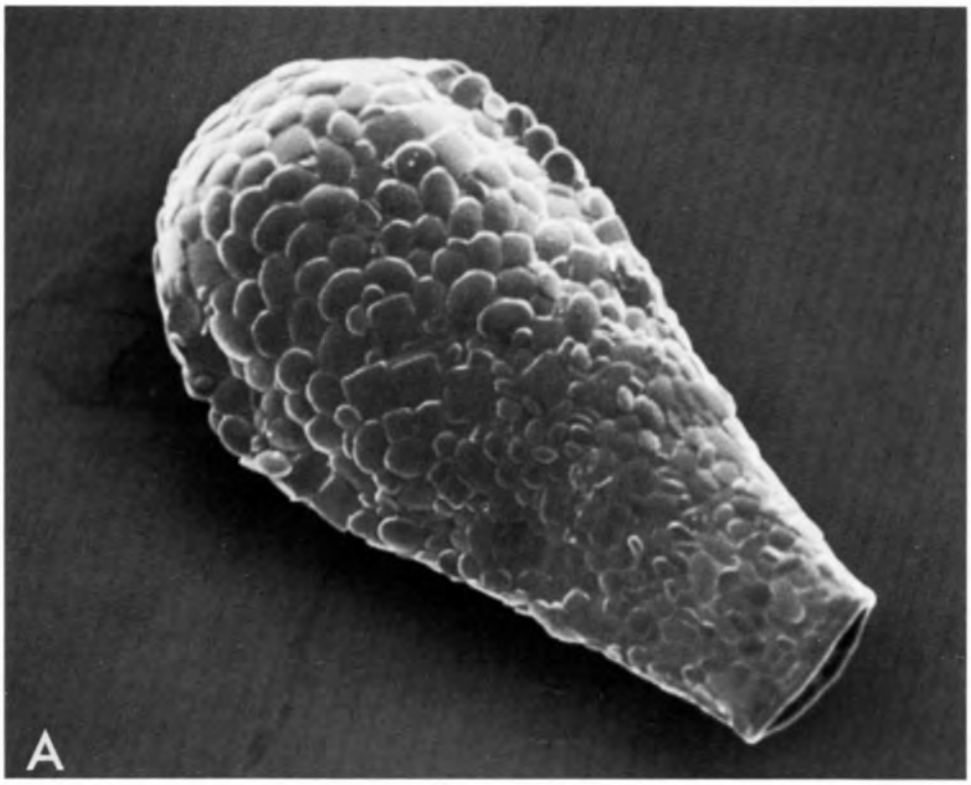
MEASUREMENTS (in μm)

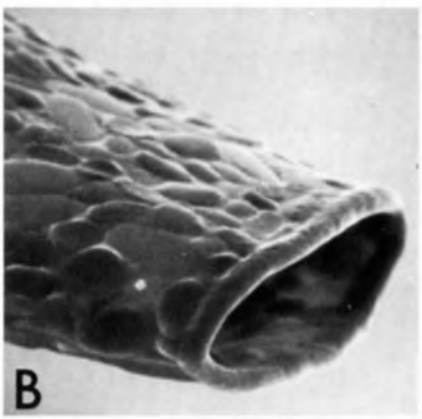
Author	Length of shell	Breadth of shell	Depth of shell	Diameter of aperture
Cash *et al.*, 1909	160–175	65–75		30–35
present work n=8	115–161	65–80	37–54	23–34

GEOGRAPHICAL DISTRIBUTION Algeria, Annobón I., Belgium, British Isles, Bulgaria, Canada, Canary I., Chile, Congo, Czechoslovakia, France, Germany, Greenland, Guatemala, Iceland, Java, Netherlands, North Africa, New Guinea, Russia, Spain, Sweden, Switzerland, West Africa.

REFERENCES Bonnet, 1966; Decloitre, 1954, 1955, 1965; Deflandre, 1936; Gauthier-Lièvre, 1954; Golemansky, 1974*b*; Gracia, 1963, 1965*b*, 1972; Grospietch, 1958*b*; Hoogenraad & Groot, 1940*a*, 1940*b*, 1946, 1948; Laminger, 1972*a*, 1973*b*; Puytorac *et al.*, 1972; Schönborn, 1966; Štěpánek, 1963.

Fig. A Broad lateral view × 700
Fig. B Lateral view of aperture × 1500
Fig. C Part of shell to show the arrangement of shell plates × 1400
Fig. D Narrow lateral view × 710


A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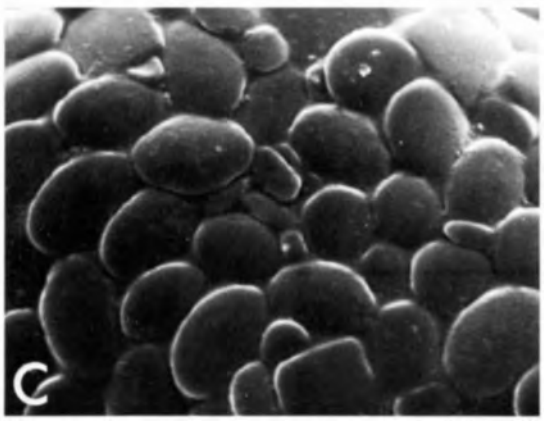
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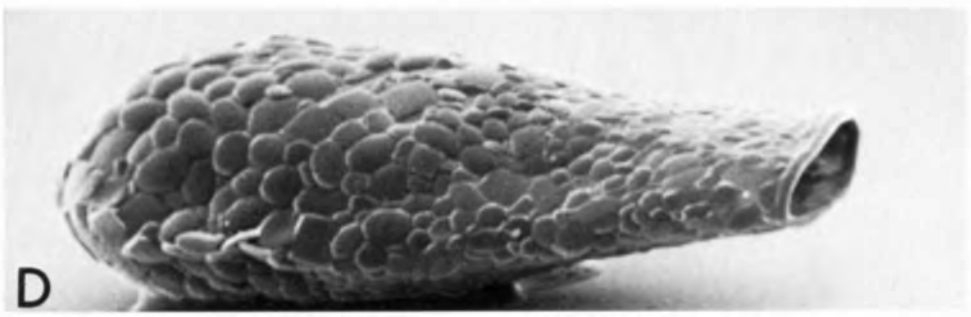

D

Nebela tincta (Leidy, 1879)

DESCRIPTION The shell is yellow, ovoid with a small neck at the aperture (Fig. A). It is laterally compressed, has small lateral pores and is composed mainly of oval or circular shell plates (Fig. B). Like *Nebela flabellum*, a thin layer of organic cement appears to overlay the shell plates. The aperture is oval and surrounded by a thin organic collar (Figs. C and D).

Deflandre (1936) listed two varieties of this species, *N.t.* var *rotunda* and *N.t.* var *major*, which have larger dimensions than the type species. As a result of a morphological study, Heal (1963) suggested that *N. tincta* was a distinct species 75–95 μm long living in relatively dry *Sphagnum*.

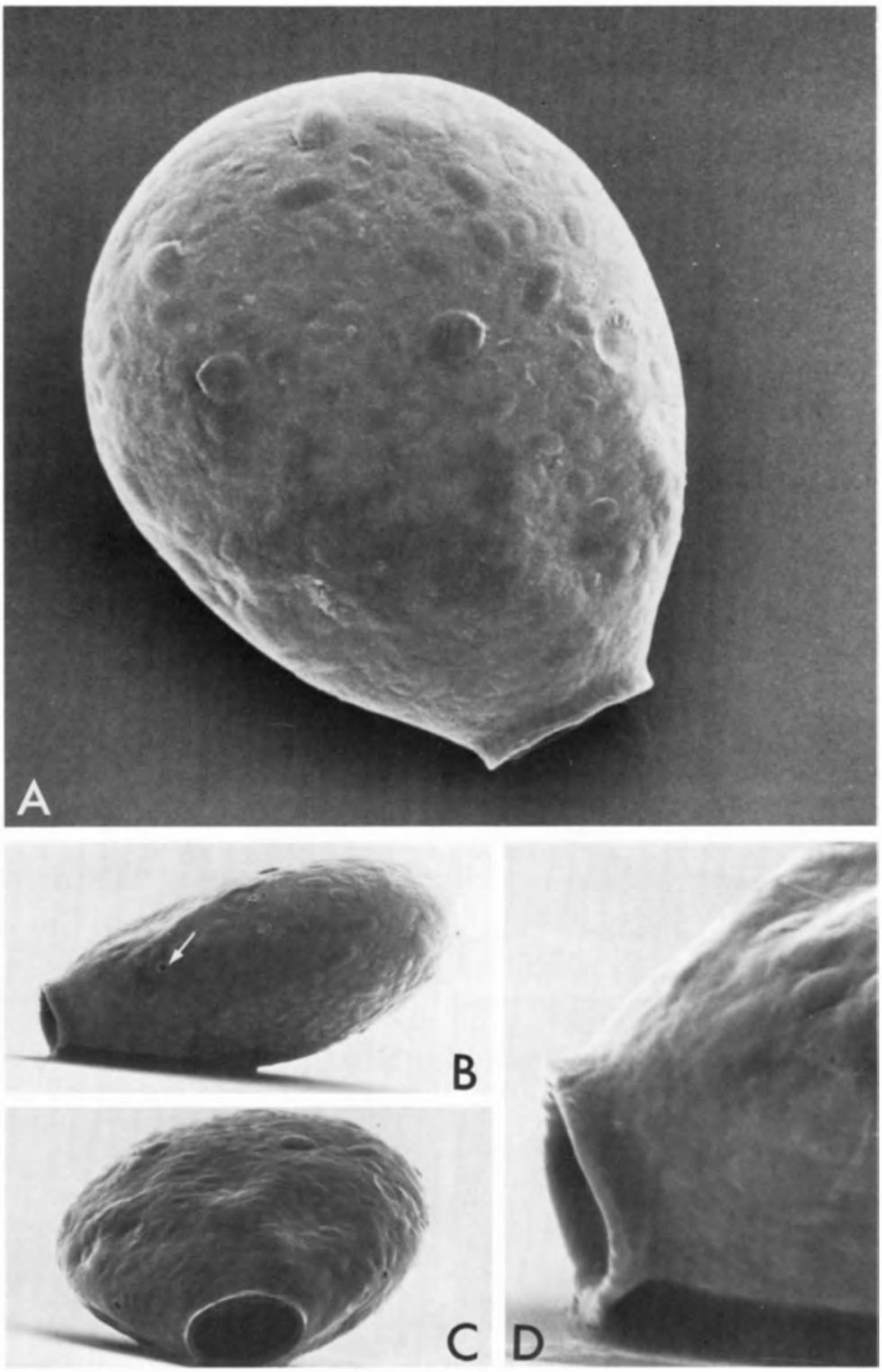
MEASUREMENTS (in μm)

Author	Length of shell	Breadth of shell	Depth of shell	Diameter of aperture
Cash *et al.*, 1909	85–90			
Deflandre, 1936	76–92	56–64		
de Graaf, 1956	80–110	54–83		20–32
present work n = 4	76–94	51–71	35–58	14–22

GEOGRAPHICAL DISTRIBUTION Annobón I., Austria, Belgium, British Isles, Bulgaria, Canada, Canary I., France, Germany, Guatemala, Iceland, Java, Marion I., Netherlands, Poland, Russia, Spain, Switzerland, Tunisia, United States of America.

REFERENCES Chardez, 1961*a*; Decloitre, 1965; Deflandre, 1936; Gauthier-Lièvre, 1954; Golemansky, 1973, 1974*b*; Graaf, 1956; Gracia, 1963, 1965*a*, 1972; Grospietch, 1958*a*, 1958*b*, 1971; Heal, 1963*b*; Hoogenraad & Groot, 1940*a*, 1940*b*; Jung, 1936*a*; Laminger, 1973*b*, 1975; Puytorac *et al.*, 1972.

Fig. A Broad lateral view × 1050
Fig. B Narrow lateral view to show the lateral pore (arrowed) × 640
Fig. C Apertural view, note the position of the lateral pores × 710
Fig. D Lateral view of aperture × 2300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Nebela tubulata Brown, 1911

DESCRIPTION The shell is colourless or yellowish-brown, flask-shaped with a distinct slender neck, and laterally compressed (Figs. A and C). It is fragile, and composed mainly of oval or circular shell plates (Fig. B). The aperture is oval and bordered by a thick lip of organic cement (Fig. D).

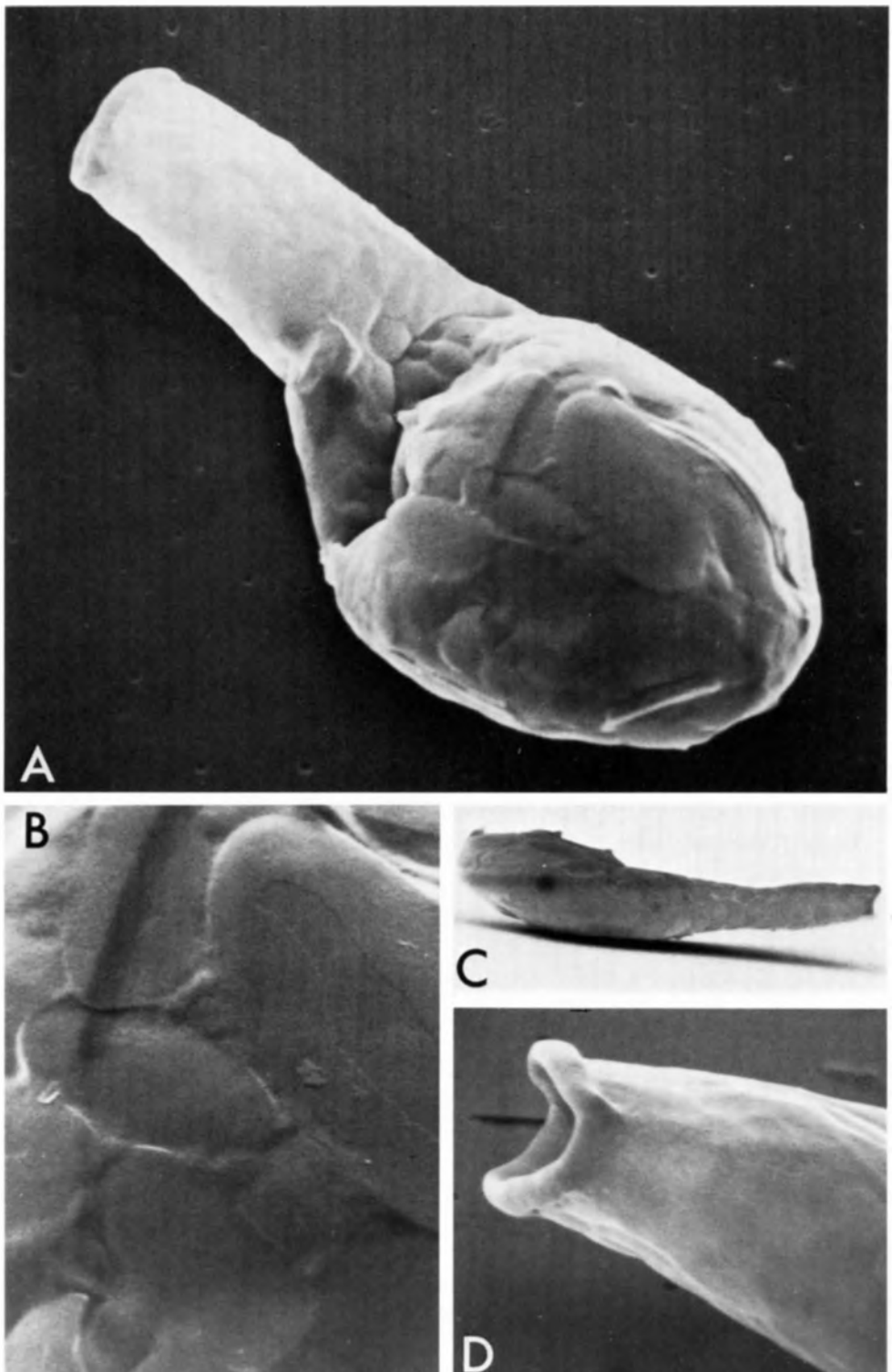
MEASUREMENTS (in μm)

Author	Length of shell	Breadth of shell	Depth of shell	Diameter of aperture
Cash *et al.*, 1919	55–74	28–48		10–15
present work n = 2	63–71	31–34	15–17	11–13

GEOGRAPHICAL DISTRIBUTION Annobón I., Australia, Belgium, British Isles, Canada, Chile, Congo, Czechoslovakia, France, Germany, Iceland, Java, Mexico, Morocco, New Guinea, New Zealand, Poland, Seychelles, Spain, Tunisia, United States of America.

REFERENCES Bonnet, 1966; Chardez, 1961*a*; Decloitre, 1965; Deflandre, 1936; Gauthier-Lièvre, 1954; Golemansky, 1973; Gracia, 1963, 1968; Hoogenraad & Groot, 1940*a*, 1946; Jung, 1936*a*; Laminger, 1972*a*; Playfair, 1918; Puytorac *et al.*, 1972.

Fig. A Lateral view of specimen slightly distorted in neck region × 2000
Fig. B Portion of shell × 4500
Fig. C Narrow lateral view × 830
Fig. D Lateral view of aperture × 4100


A
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D

Nebela tubulosa Penard, 1890

DESCRIPTION The shell is yellow or brown, ovoid with a distinct neck (Fig. A). The lateral margins begin at the base of the neck and extend all round (Figs. A and C), small lateral pores are present although they are often difficult to see. The shell is composed of a mixture of oval, circular and quadrangular shell plates which are usually arranged haphazardly and overlap (Fig. E). The aperture is oval and surrounded by a thin collar of organic cement (Figs. B and D).

Cash (1909) described the presence of 'fine punctulations' around the neck of some specimens, which he considered was organic cement producing a rough surface, and the only other feature that appeared to vary was the mixture of shell plates.

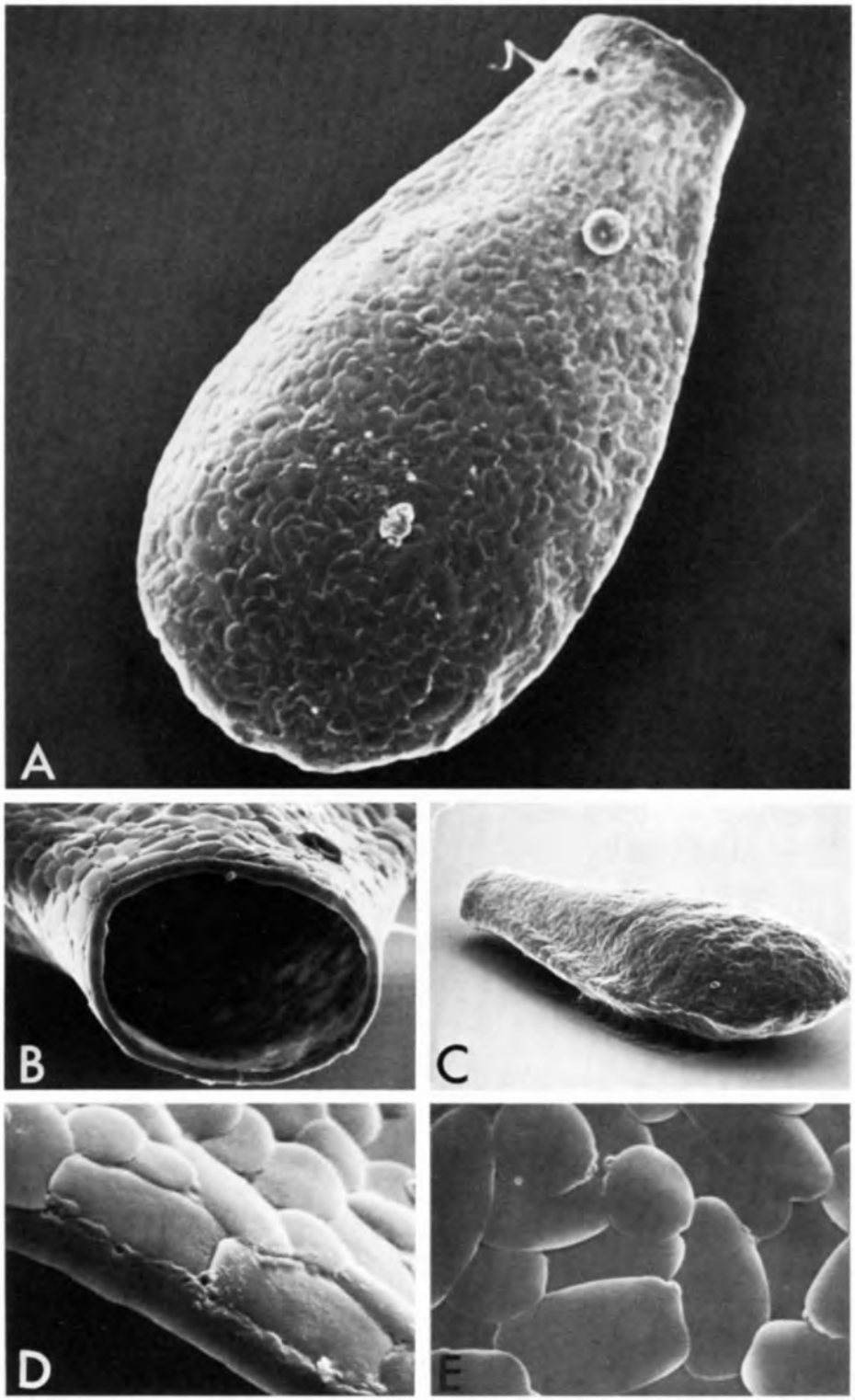
MEASUREMENTS (in μm)

Author	Length of shell	Breadth of shell	Depth of shell	Diameter of aperture
Cash *et al.*, 1909	190–220			
Deflandre, 1936	190–215	80–125		35–63
present work n = 8	213–264	120–155	54–71	42–54

GEOGRAPHICAL DISTRIBUTION Algeria, Austria, Belgium, British Isles, Canada, Canary I., Colombia, Congo, Czechoslovakia, France, Germany, Greenland, Hungary, Iceland, Italy, Java, Poland, Russia, Seychelles, Spain, Sunda I., Sweden, Switzerland, United States of America, Venezuela, West Africa.

REFERENCES Bonnet, 1966; Chardez, 1961*a*; Decloitre, 1965; Deflandre, 1936; Gauthier-Lièvre, 1954; Grospietch, 1958*b*; Laminger, 1972*a*, 1975; Puytorac *et al.*, 1972; Schönborn, 1975; Steinecke, 1914; Štěpánek, 1963.

Fig. A Broad lateral view × 500
Fig. B Apertural view × 790
Fig. C Narrow lateral view × 240
Fig. D Portion of apertural collar to show the junction with the shell plates × 2900
Fig. E Part of shell surface × 2700


A
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D
E

Nebela vitraea Penard, 1899

DESCRIPTION The shell is colourless, ovoid and compressed laterally (Figs. A and C). It is composed of a mixture of oval, circular and elongate shell plates which overlap each other (Fig. D). The aperture is oval and surrounded by a border of shell plates (Fig. B).

Cash (1909) stated that *N. vitrae* could be distinguished from *N. dentistoma* by the structure of the shell and the outline of the aperture. Two varieties of this species, *N.v.* var *minor* and *N.v.* var *sphangi*, both smaller than Penard's (1899) original specimens, were redescribed by Deflandre (1936). Our observations suggest that it is possible to separate *N. vitraea* from *N. dentistoma* in the arrangement of the shell plates and the size of the aperture, but further specimens must be examined to establish these characters.

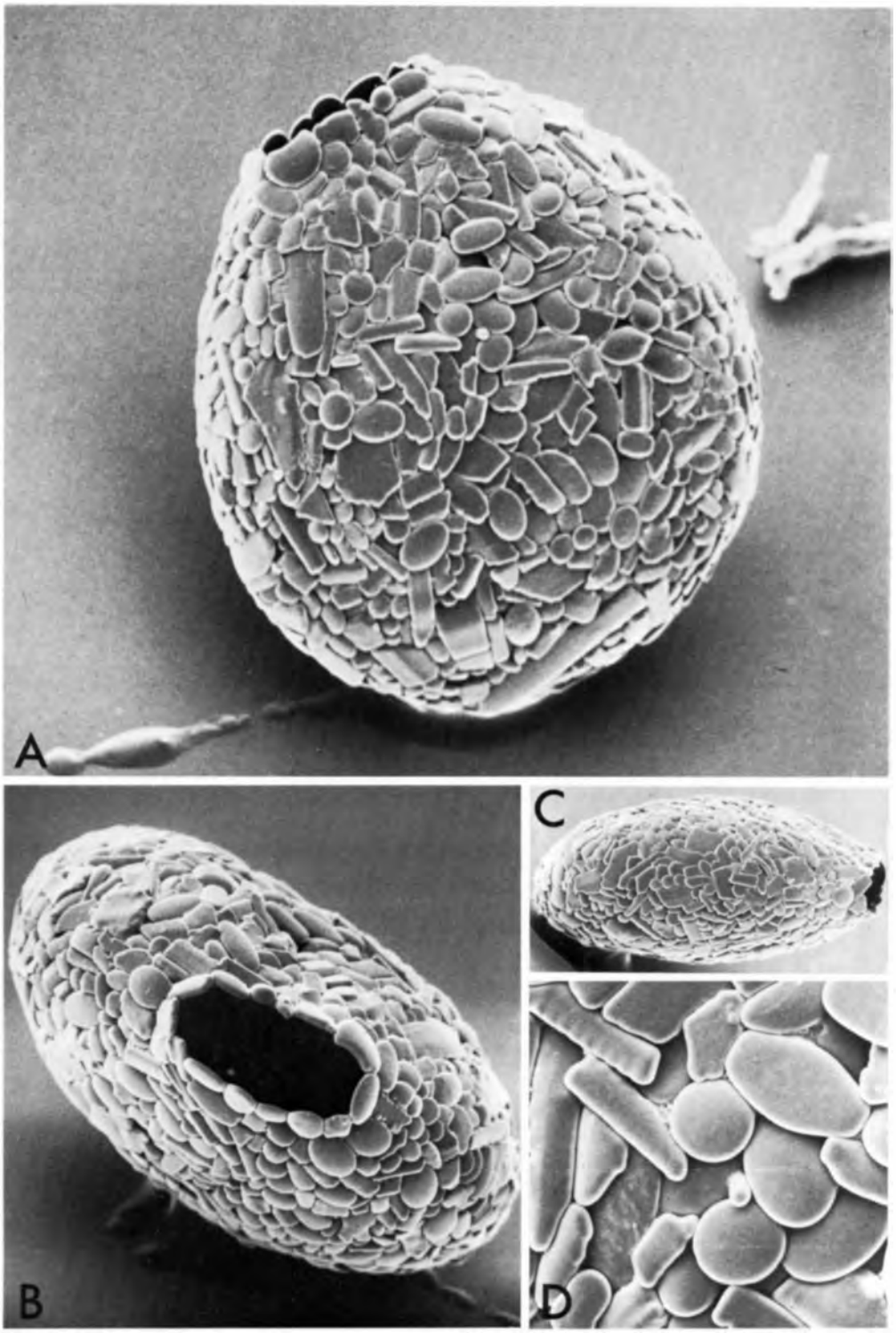
MEASUREMENTS (in μm)

Author	Length of shell	Breadth of shell	Depth of shell	Diameter of aperture
Cash *et al.*, 1909	95–120			
Deflandre, 1936	170–200			
present work n = 5	117–160	102–145	55–95	28–37

GEOGRAPHICAL DISTRIBUTION Austria, British Isles, Canada, Costa Rica, France, Germany, Mexico, Switzerland, United States of America.

REFERENCES Deflandre, 1936; Grospietch, 1958*b*; Laminger, 1972*c*, 1973*b*, 1975.

Fig. A Broad lateral view × 720
Fig. B Apertural view × 460
Fig. C Narrow lateral view × 370
Fig. D Portion of shell to show overlapping shell plates × 1600


A
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Quadrulella symmetrica (Wallich, 1863)

DESCRIPTION The shell is colourless, ovoid or pyriform and composed of quadrangular, siliceous shell plates (Fig. A). It is compressed laterally especially in the apertural region (Fig. D). The shell plates are usually arranged in a regular manner, often in rows, with smaller plates close to the aperture (Figs. A, B and D). The aperture is oval, often concave in lateral view, and surrounded by a thin collar of organic cement (Figs. C and D).

Differences in the breadth of specimens was recorded by Cash (1909), whilst Deflandre (1936) redescribed *Q. symmetrica* and three varieties, var. *longicollis*, var. *irregularis* and var. *curvata*.

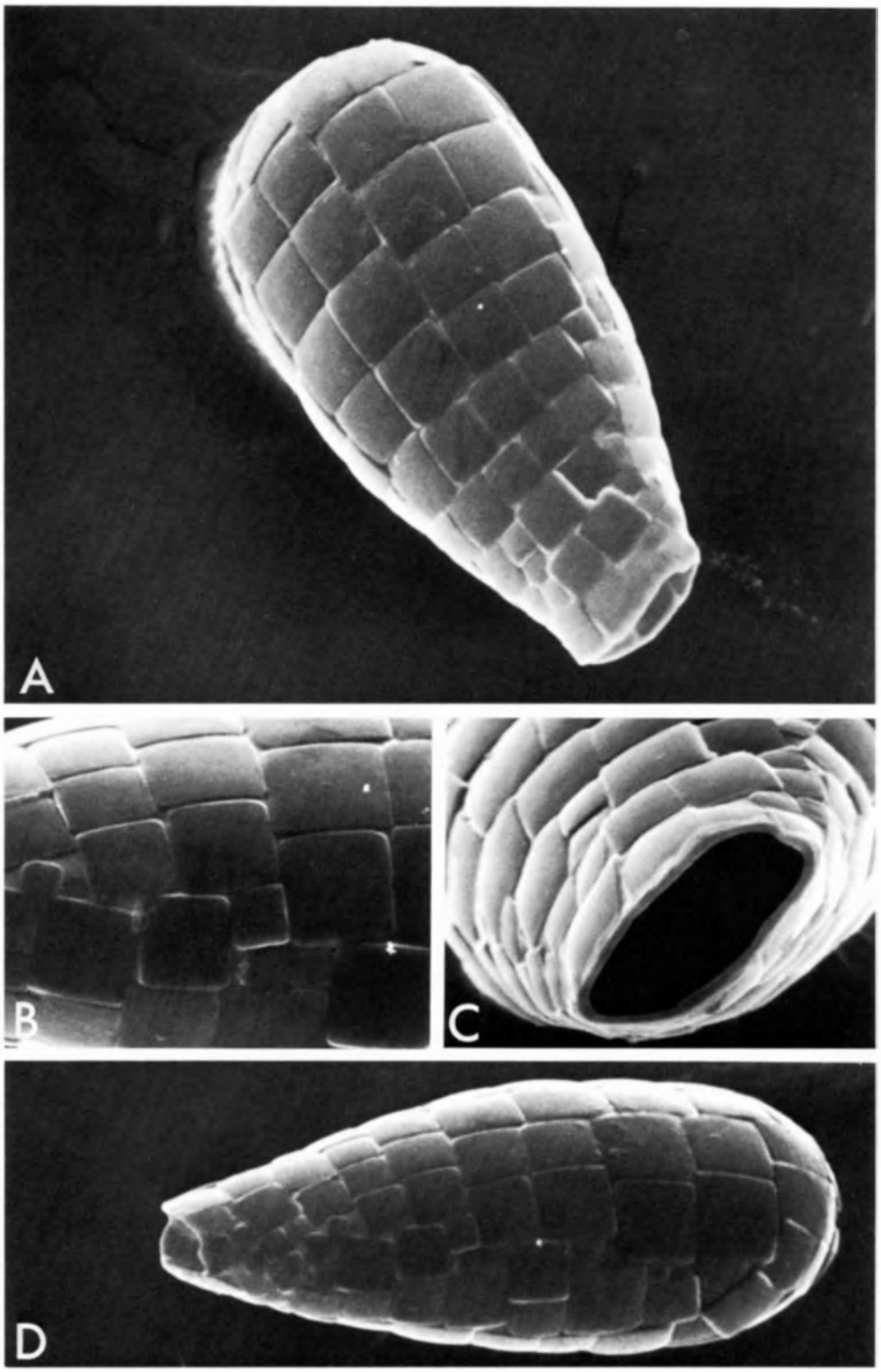
MEASUREMENTS (in μm)

Author	Length of shell	Breadth of shell	Depth of shell	Diameter of aperture
Cash *et al.*, 1909	96	60–70		
Deflandre, 1936	68–120	45–74		
present work n = 12	72–103	36–52	27–35	18–22

GEOGRAPHICAL DISTRIBUTION Algeria, Angola, Annobón, I., Austria, Belgium, British Isles, Bulgaria, Canada, Congo, Costa Rica, France, Germany, Greenland, Guatemala, Iceland, Russia, Spain, Sumatra, Sweden, Switzerland, Tunisia, United States of America, West Africa.

REFERENCES Bonnet, 1960, 1966; Chardez, 1961*a*; Decloitre, 1965; Deflandre, 1936; Deflandre & Deflandre-Rigaud, 1958; Gauthier-Lièvre, 1954; Golemansky, 1974*b*; Gracia, 1963, 1972; Grospietch, 1958*a*, 1958*b*; Hoogenraad & Groot, 1940*a*, 1940*b*; Laminger, 1972*a*, 1973*b*, 1975; Puytorac *et al.*, 1972; Schönborn, 1975; Štěpanek, 1963.

Fig. A Lateral view × 1200
Fig. B Portion of shell to show the arrangement of shell plates × 2100
Fig. C Apertural view × 2000
Fig. D Narrow lateral view × 1200


A
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D

Difflugia acuminata Ehrenberg, 1838

DESCRIPTION The shell is brown, cylindrical with a pointed or acuminate aboral region (Figs. A and C). The surface is rough and covered with quartz particles and occasionally with fragments of diatoms. The aperture is circular and often covered with a thin layer of organic cement which gives it a smooth outline (Fig. B).

Cash (1909) suggested that there was such a gradation of shape and size between specimens that they could not be considered as varieties. Nevertheless, he did list two varieties *D. a.* var. *inflata* and *D. a.* var. *curvata.*

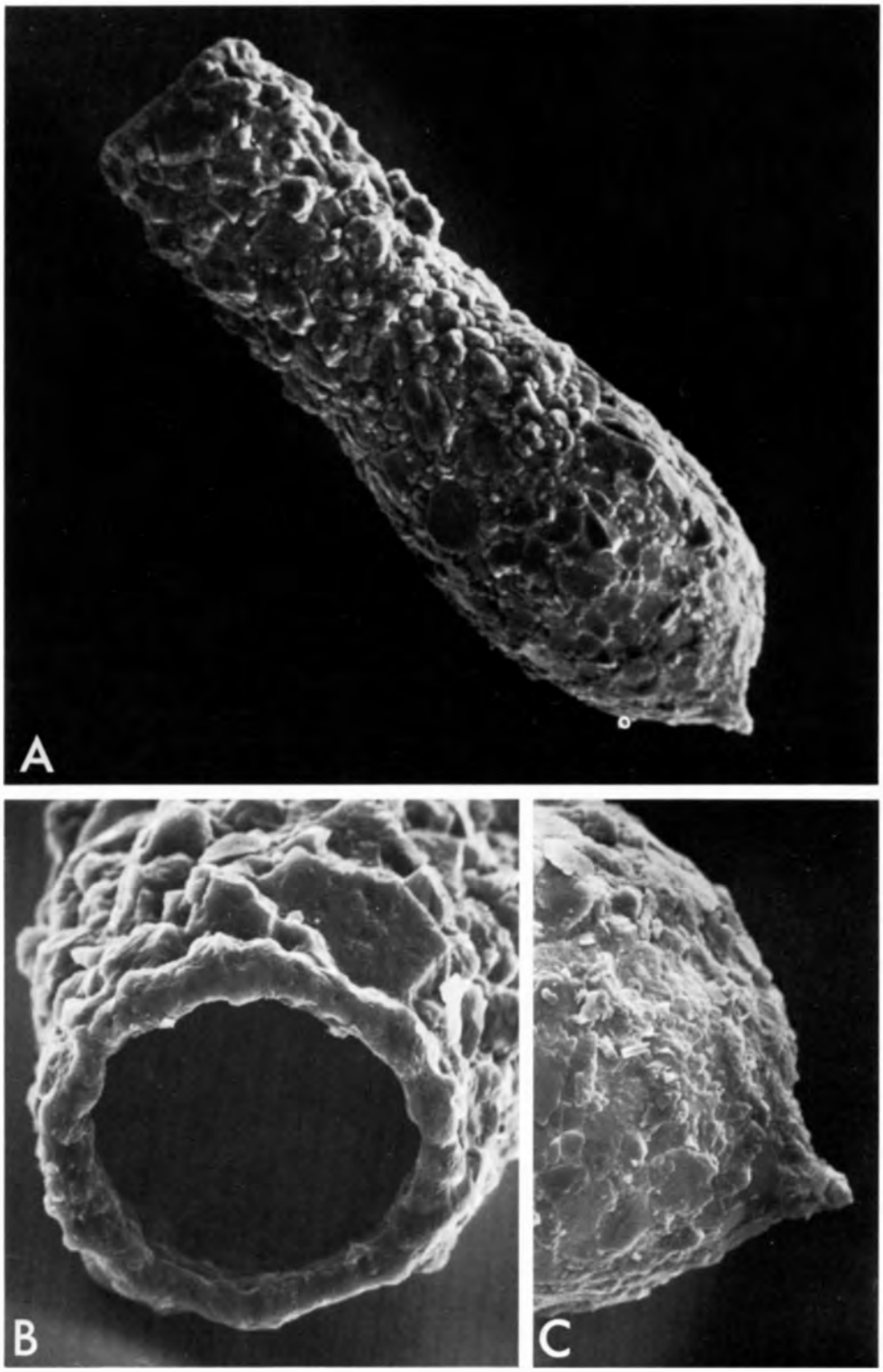
MEASUREMENTS (in μm)

Author	Length of shell	Breadth of shell	Diameter of aperture
Cash *et al.*, 1909	100–300	35–95	
present work n = 1	232	72	36

GEOGRAPHICAL DISTRIBUTION Algeria, Argentina, Australia, Austria, Belgium, Brazil, British Isles, Canada, China, Czechoslovakia, Finland, France, Germany, Italy, Japan, Java, Morocco, Netherlands, Paraguay, Poland, Roumania, Russia, Sweden, Switzerland, United States of America, Venezuela, West Africa.

REFERENCES Boltovskoy & Lena, 1966, 1974; Chardez, 1961*b*; Decloitre, 1954; Deflandre, 1926; Gauthier-Lièvre & Thomas, 1958; Godenau *et al.*, 1973; Golemansky, 1970; Green, 1975; Grospietch, 1975; Laminger, 1971, 1972*c*, 1975; Playfair, 1918; Rampi, 1947; Schönborn, 1975.

Fig. A Lateral view × 550
Fig. B View of aperture × 1300
Fig. C View of aboral region × 1200


A
B
C

Difflugia avellana Penard, 1890

DESCRIPTION The shell is brown, elongated oval in shape tapering towards the aperture, and laterally compressed (Figs. A and B). The aboral region curves in a graceful arc. It is composed of sand grains. The aperture is oval or circular, and is surrounded by a regular array of small particles (Fig. D) which sometimes vary in size (Fig. C).

The size of the particles used to construct an individual shell is variable, but the general outline can easily be distinguished.

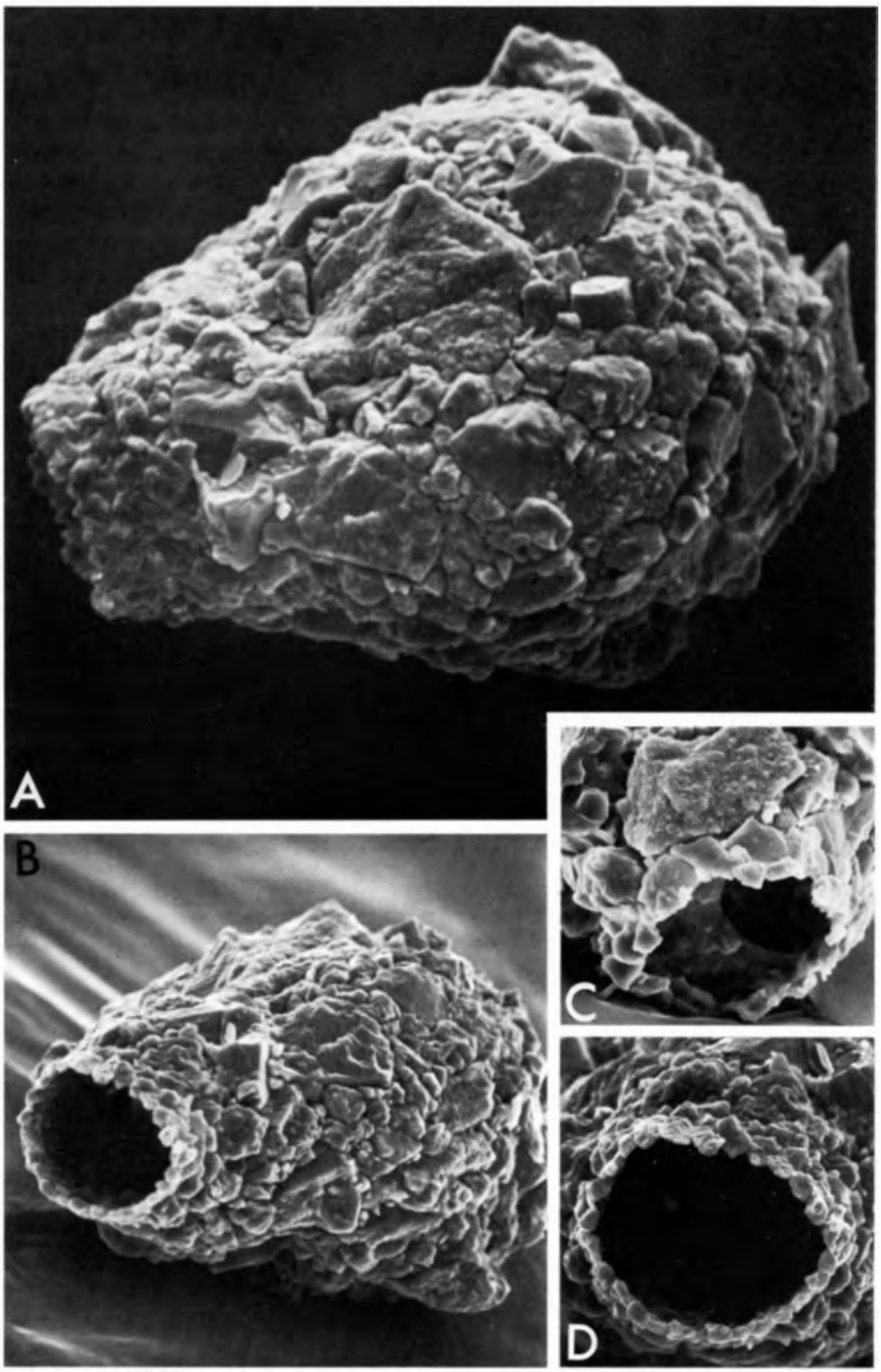
MEASUREMENTS (in μm)

Author	Length of shell	Breadth of shell	Depth of shell	Diameter of aperture
Penard, 1890	100–150	60–90		
Penard, 1902	125–160			
present work n=7	130–162	105–130	86–95	36–43

GEOGRAPHICAL DISTRIBUTION Algeria, Argentina, Austria, Belgium, British Isles, Czechoslovakia, Finland, France, Germany, Italy, Marion I., Mexico, Nepal, Russia, Switzerland.

REFERENCES Boltovskoy & Lena, 1966; Chardez, 1961*a*; Chibisova, 1967; Gauthier-Lièvre & Thomas, 1958; Grospietch, 1971; Laminger, 1972*c*, 1972*b*, 1973*b*; Štěpánek, 1967.

Fig. A Broad lateral view × 630
Fig. B Narrow lateral view × 530
Fig. C View of aperture × 700
Fig. D View of aperture × 720


A
B
C
D

Difflugia bacillariarum Perty, 1849

DESCRIPTION The shell is colourless, ovoid and circular in transverse section (Figs. A and B). It is composed of thin siliceous plates overlaid by diatom frustules. The aperture is circular, but the shape is often masked by diatom shells (Fig. C).

There has been considerable confusion between this species and *Difflugia elegans*. The main differences are that *D. elegans* is composed mainly of sand-grains overlaid with diatom shells, and has a distinct constriction just posterior to the aperture. The presence or absence of a terminal protruberance as a diagnostic character is questionable. It is absent on our two specimens of *D. bacillariarum*, but most of our specimens of *D. elegans* have a pronounced horn.

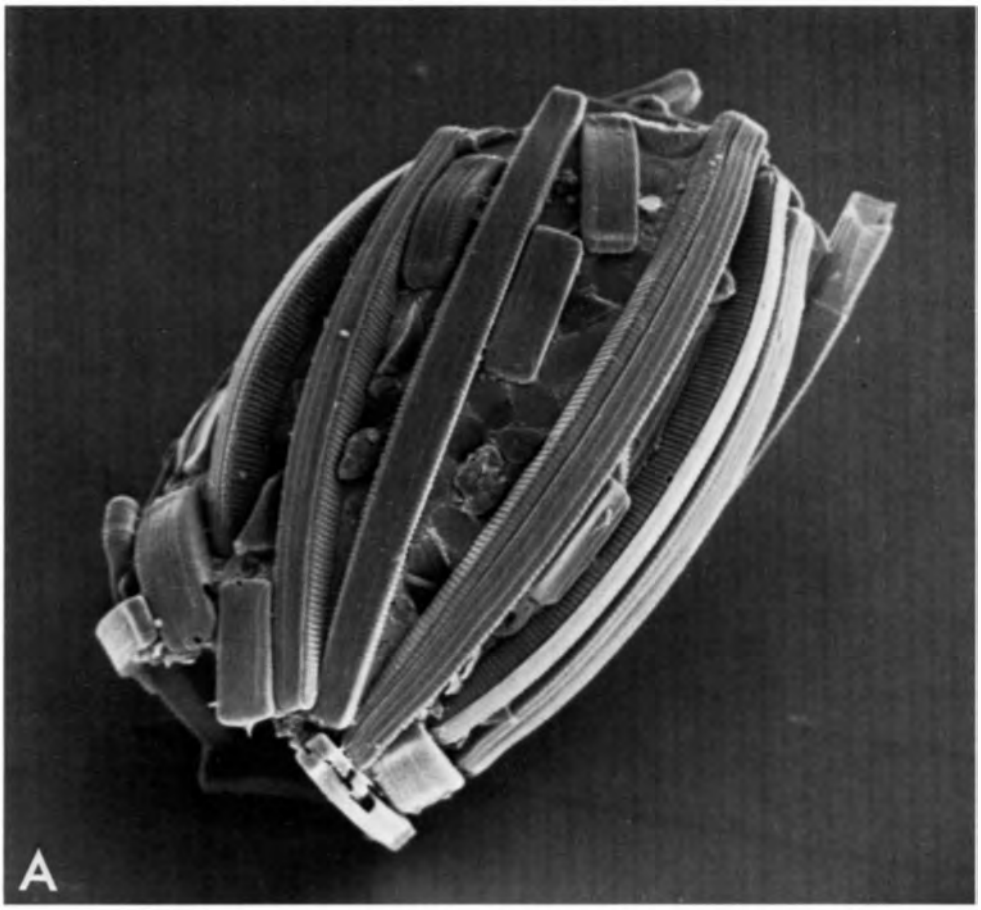
MEASUREMENTS (in μm)

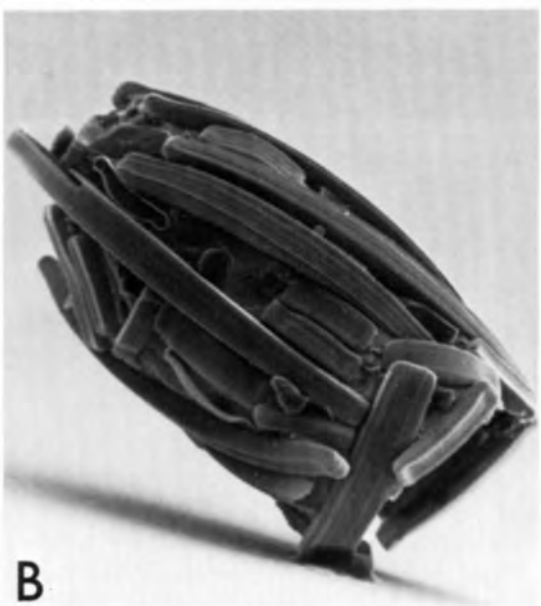
Author	Length of shell	Breadth of shell	Diameter of aperture
Cash *et al.*, 1909	94–100		
present work n = 2	67–69	40–44	22–24

GEOGRAPHICAL DISTRIBUTION Argentina, Australia, Belgium, British Isles, Canada, China, Congo, France, Germany, Roumania, Sudan, Switzerland, United States of America.

REFERENCES Chardez, 1961*a*; Gauthier-Lièvre & Thomas, 1958; Godenau *et al.*, 1973; Heal, 1963*b*; Playfair, 1918; Puytorac *et al.*, 1972; Štěpánek, 1963; Vucetich, 1972.

Fig. A Lateral view × 1400
Fig. B Lateral view × 890
Fig. C Apertural view × 1200


A


B


C

Difflugia bacillifera Penard, 1890

DESCRIPTION The shell is brown, ovoid or elongate, and the outline is often concealed by adhering diatom frustules (Figs. A and B). Cash (1909) suggested that the extent to which diatom frustules are incorporated was dependent on the season. Our specimens have attached various diatoms from the genera, *Tabellaria*, *Frustulia*, *Pinnularia* and *Eunotia*, but we have not observed any seasonal trends (Figs. A and B). The aperture is circular and surrounded by small quartz particles (Fig. C).

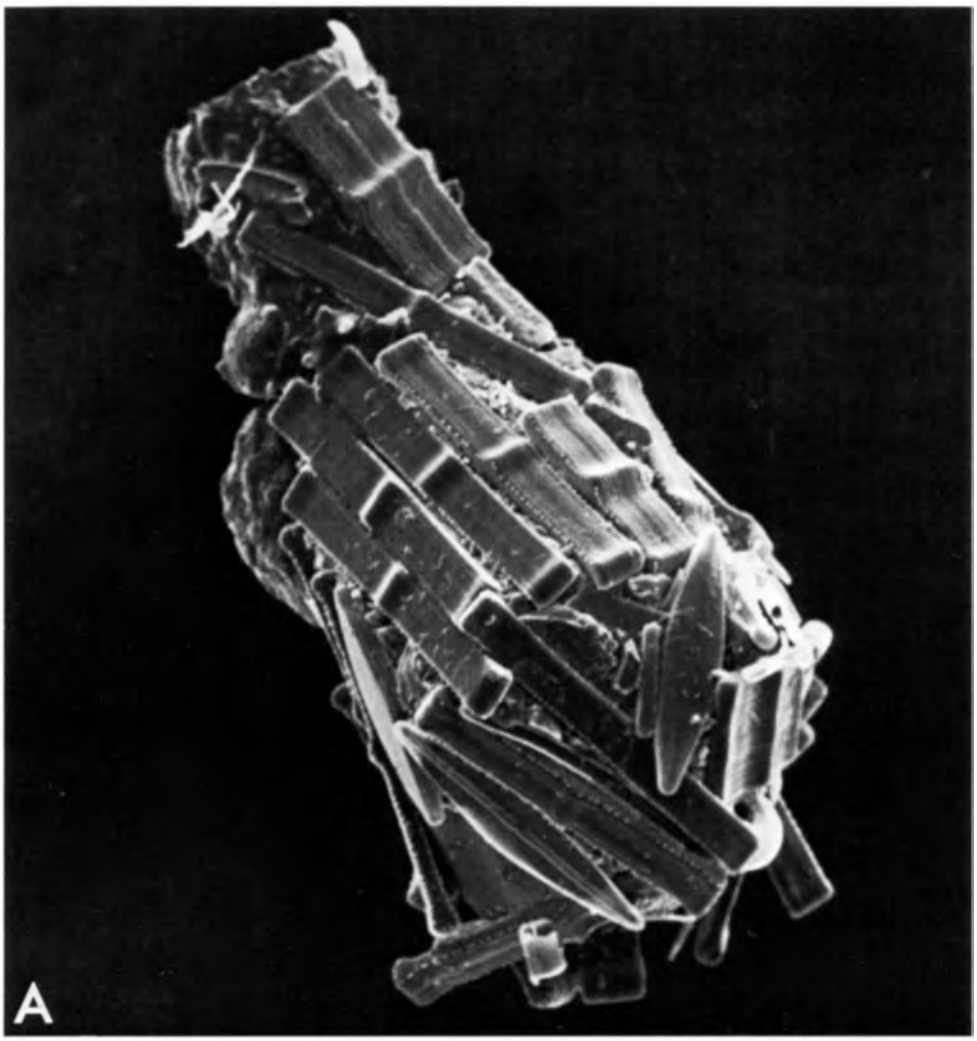
MEASUREMENTS (in μm)

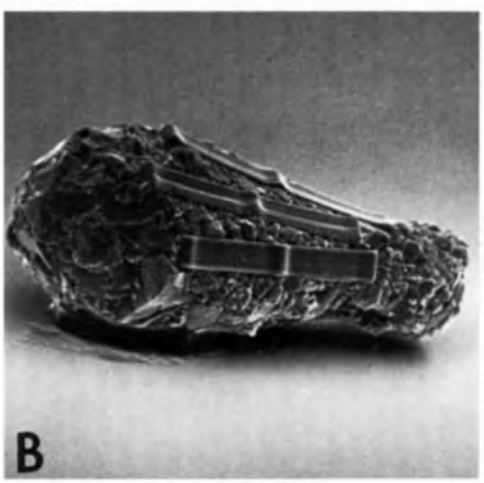
Author	Length of shell	Breadth of shell	Diameter of aperture
Cash *et al.*, 1909	145–160		
present work n = 8	130–194	59–91	25–36

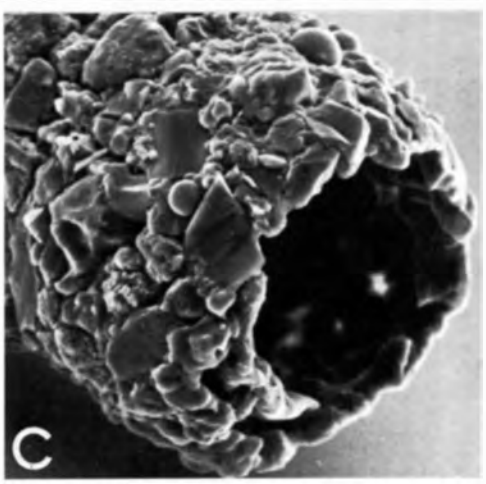
GEOGRAPHICAL DISTRIBUTION Algeria, Belgium, British Isles, Bulgaria, Canada, Canary I., Chile, Colombia, Finland, France, Germany, Hungary, Iceland, Netherlands, Roumania, Russia, Spain, Sweden, Switzerland, Tunisia, United States of America, West Africa.

REFERENCES Chardez, 1961*a*, 1966; Decloitre, 1948, 1965; Gauthier-Lièvre & Thomas, 1958; Godenau *et al.*, 1973; Heal, 1963*b*; Jung, 1936*a*; Laminger, 1972*a*; Puytorac *et al.*, 1972; Steineke, 1914.

Fig. A Broad lateral view × 630
Fig. B Narrow lateral view × 1600
Fig. C View of aperture × 410


A


B


C

Difflugia claviformis Penard, 1899

DESCRIPTION The shell is brown, pyriform with the apical region having a terminal conical protruberance (Fig. A). The sides swell evenly from the aperture to reach their widest diameter and then curve gracefully to the conical protruberance (Fig. B). It has a smooth outline and is composed mainly of sand-grains held together by a mesh of organic cement (Fig. C). The aperture is circular and surrounded by an even arrangement of small particles (Fig. D).

These specimens are in agreement with Penard's original description (Penard, 1899).

MEASUREMENTS (in μm)

Author	Length of shell	Breadth of shell	Diameter of aperture
Penard, 1899	390–435	130–200	
present work n = 12	247–393	97–196	33–62

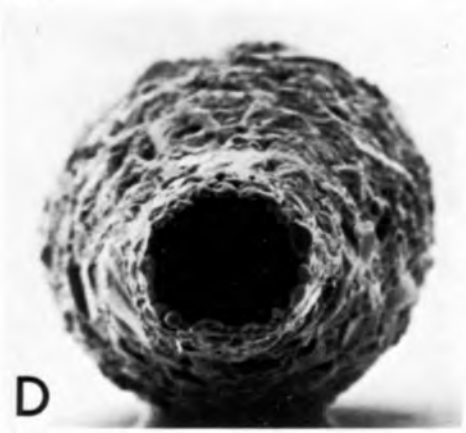
GEOGRAPHICAL DISTRIBUTION Austria, Belgium, British Isles, Czechoslovakia, France, Germany, Switzerland, Venezuela, United States of America.

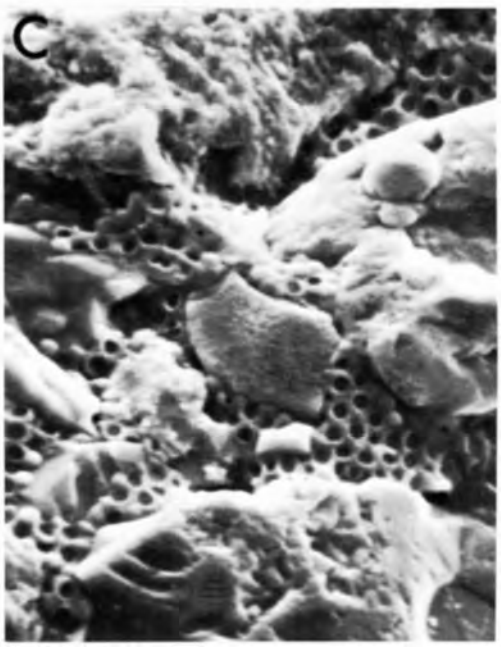
REFERENCES Chardez, 1961*a*; Grospietch, 1975; Laminger, 1971, 1972*c*, 1975; Štěpánek, 1967.

Fig. A Latero-apertural view × 410
Fig. B Lateral view × 200
Fig. C Portion of shell surface showing the organic cement mesh × 520
Fig. D View of aperture × 4500


A


B


D


C

Difflugia corona Wallich, 1864

DESCRIPTION The shell is brown, spherical or ovoid and has a variable number of spines on the aboral region (Figs. A and C). It is composed of quartz particles, with the small pieces being cemented into the gaps between larger pieces to produce a relatively uniform surface. The aperture is circular and surrounded by a denticular collar (Fig. B). The tooth-like structures are evenly spaced, number between 12 to 20, and are composed of small particles cemented together (Fig. D).

A study of cultured and wild specimens of *D. corona* by Jennings (1916 and 1937) showed that this species varied considerably in size and shape. The aboral spines are easily broken because they project some distance from the shell, so that variation of this feature should be expected.

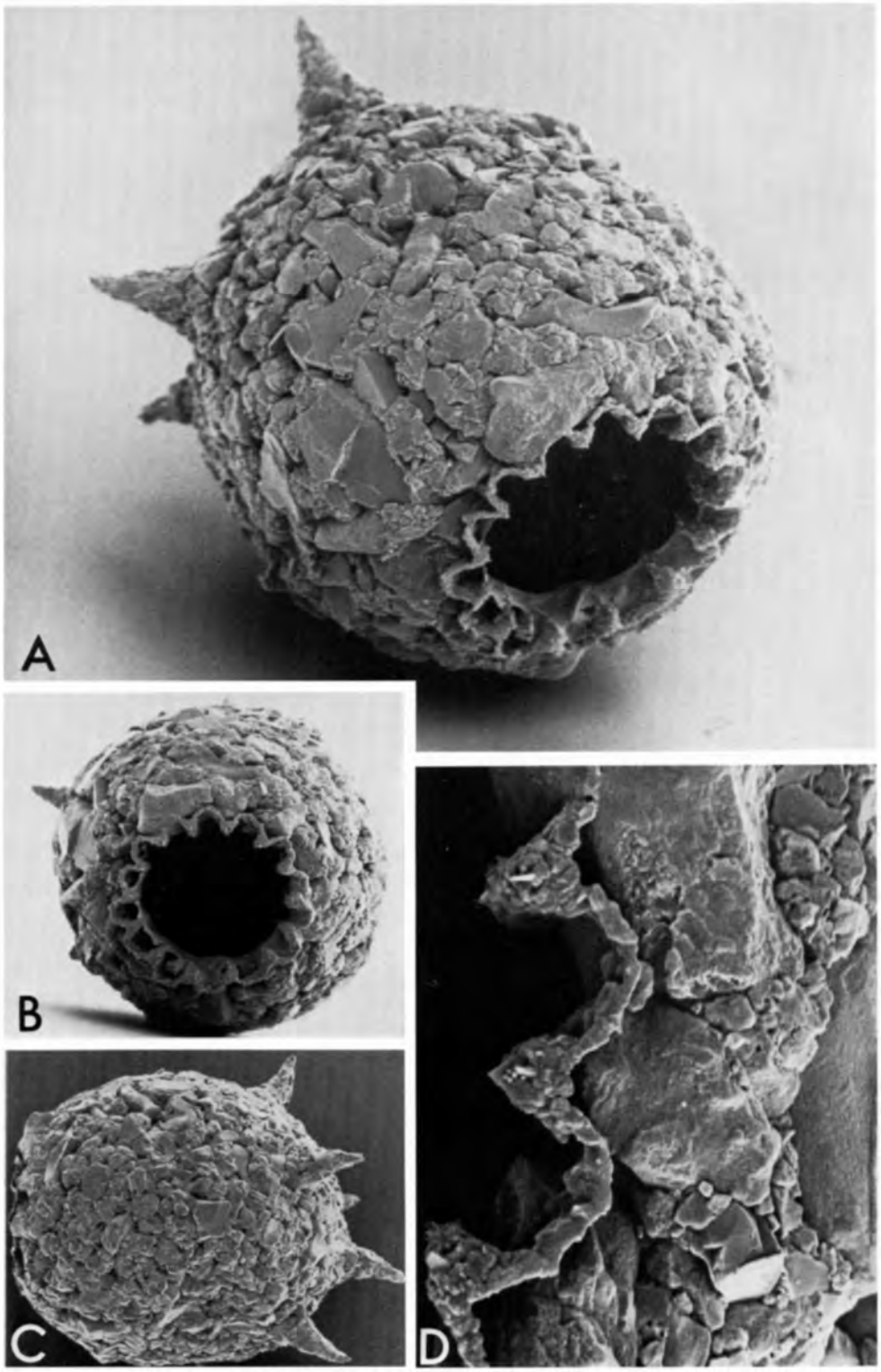
MEASUREMENTS (in μm)

Author	Length of shell	Breadth of shell	Diameter of aperture
Cash *et al.*, 1909	180–230		
present work n = 10	137–189	141–176	51–83

GEOGRAPHICAL DISTRIBUTION Algeria, Argentina, Austria, Belgium, British Isles, Brazil, Canada, Congo, Finland, France, Germany, Greenland, Roumania, Sudan, Switzerland, United States of America, Venezuela, West Africa.

REFERENCES Boltovskoy & Lena, 1971, 1974; Chardez, 1961*a*; Deflandre, 1926; Gauthier-Lièvre & Thomas, 1958; Godenau *et al.*, 1973; Green, 1975; Laminger, 1975; Vucetich, 1972.

Fig. A View to show aperture and aboral spines × 430
Fig. B Apertural view × 250
Fig. C Lateral view × 220
Fig. D Part of denticular collar × 1400


A
B
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D

Difflugia curvicaulis Penard, 1899

DESCRIPTION The shell is colourless or brown, elongate or ovoid, circular in transverse section, and the aboral region terminates with a tubular horn which is often curved and perforated at its apex (Figs. A and B). It is composed of siliceous particles, often interspersed with a mesh of organic cement (Fig. C), arranged to give a smooth outline to the shell. The aperture is circular and surrounded by a rim of small particles (Fig. D).

This species was considered by Cash (1909) to differ from *D. acuminata* only in the form of the terminal horn. Examination of our specimens shows that *D. curvicaulis* differs from *D. acuminata* and *D. elegans* in the smoothness of the shell, the shape, and in the form of the aperture.

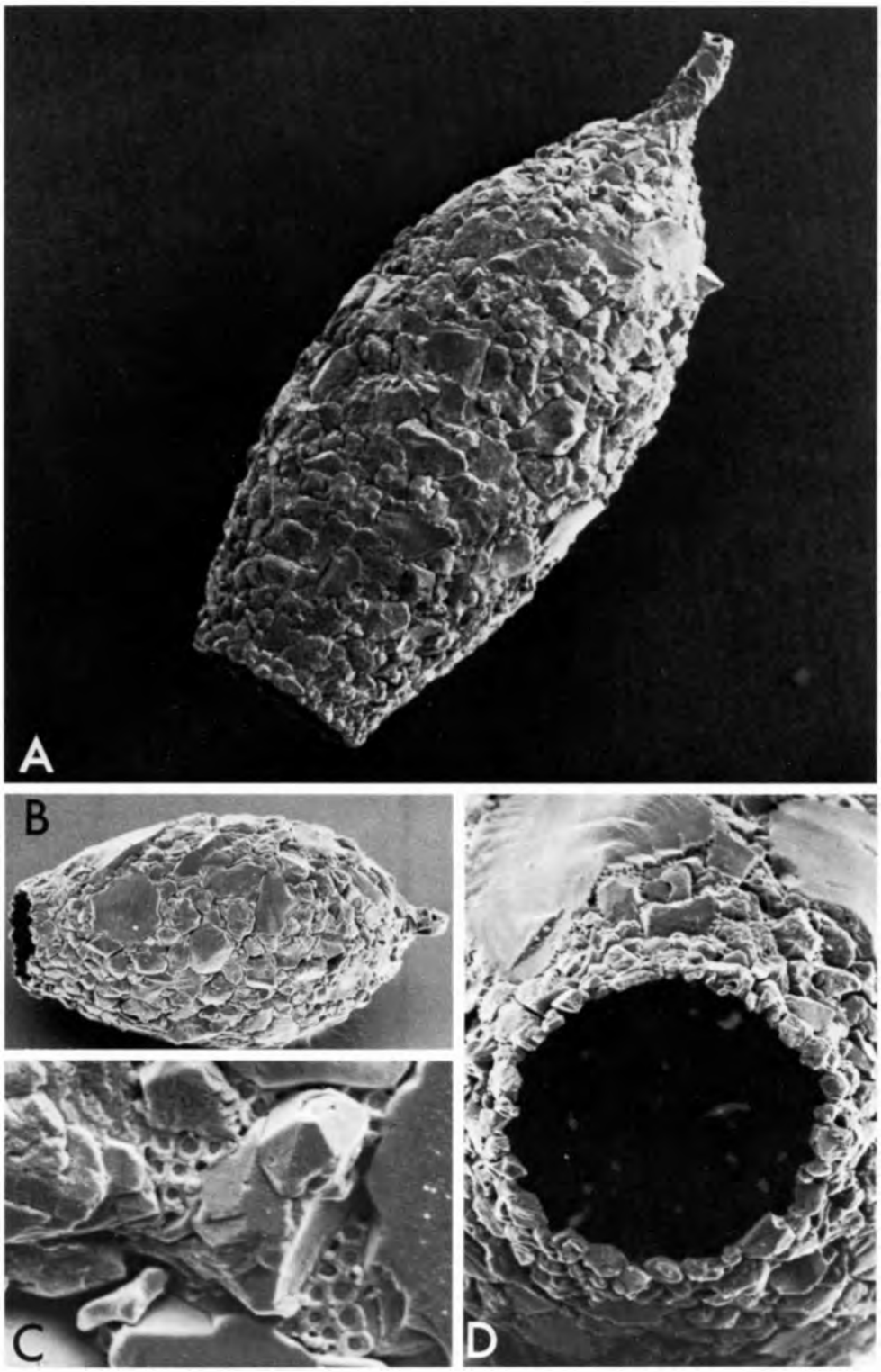
MEASUREMENTS (in μm)

Author	Length of shell	Breadth of shell	Diameter of aperture
Cash *et al.*, 1909	170–200		
present work n = 7	146–191	74–88	34–42

GEOGRAPHICAL DISTRIBUTION Algeria, Austria, Belgium, British Isles, Congo, Czechoslovakia, France, Germany, Morocco, Sweden, Switzerland, West Africa.

REFERENCES Chardez, 1961*a*; Gauthier-Lièvre & Thomas, 1958; Laminger, 1972*c*; Steineke, 1914; Štěpánek, 1967.

Fig. A Lateral view × 550
Fig. B Latero-apertural view × 370
Fig. C Portion of shell to show the organic cement mesh × 4000
Fig. D View of aperture × 1050


A
B
C
D

Difflugia elegans Penard, 1890

DESCRIPTION The shell is brown, ovoid with an acuminate aboral region which terminates in a tubular horn, and there is a distinct constriction posterior to the aperture (Fig. A). In transverse section it is circular, and is composed of sand-grains and diatom frustules (Fig. C). The aperture is circular and surrounded by an irregular arrangement of particles and diatoms (Fig. B).

Variation in the construction of the test is considerable, as is the length of the tubular horn, but the constriction behind the aperture distinguishes this species from *D. bacillariarum* which it closely resembles.

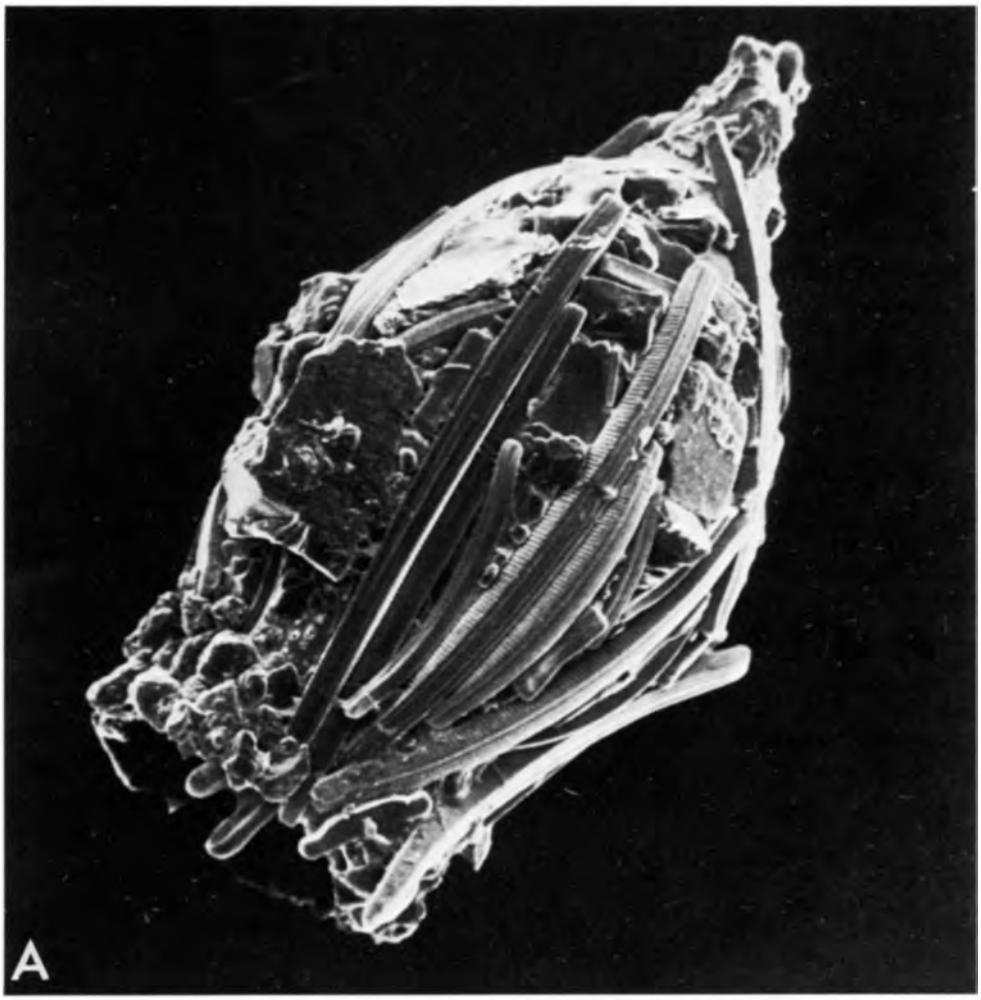
MEASUREMENTS (in μm)

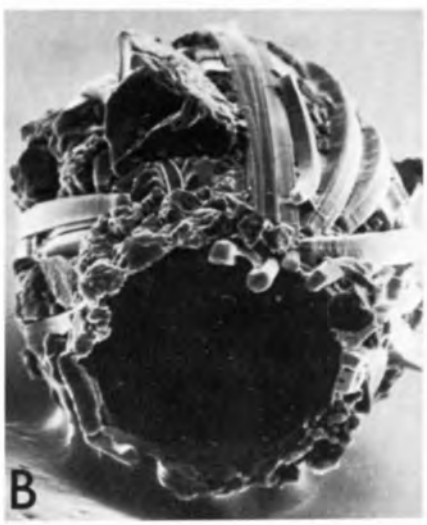
Author	Length of shell	Breadth of shell	Diameter of aperture
Penard, 1890	80–100	30–40	
Cash *et al.*, 1909	100–120		
present work n = 14	117–158	69–99	39–55

GEOGRAPHICAL DISTRIBUTION Algeria, Argentina, Austria, Brazil, British Isles, Bulgaria, China, Congo, Costa Rica, Czechoslovakia, Faroes, France, Germany, Guatemala, Hungary, Iceland, Italy, Japan, Luxembourg, Mexico, Netherlands, Poland, Roumania, Russia, Sudan, Sweden, Switzerland, United States of America, Venezuela, West Africa.

REFERENCES Boltovskoy & Lena, 1974; Chardez, 1961*a*; Decloitre, 1965; Deflandre, 1926; Ertl, 1965; Gal, 1969; Gauthier-Lièvre & Thomas, 1958; Godenau *et al.*, 1973; Golemansky, 1970, 1974*b*; Green, 1975; Jung, 1936*a*; Laminger, 1972*a*, 1972*c*, 1973*b*, 1975; Schönborn, 1966, 1975; Steineke, 1914; Štěpánek, 1963.

Fig. A Latero-apertural view × 850
Fig. B Apertural view × 750
Fig. C Lateral view × 440


A


B


C

Difflugia globulosa Dujardin, 1837

DESCRIPTION The shell is brown, spherical or hemispherical, usually composed of large quartz particles but may also include diatom frustules (Figs. A and B). The general appearance is a rough shell although some smoother forms have been seen. The aperture is circular, and surrounded by smaller particles which often appear smooth due to the overlying cement (Fig. C).

Variation in this species is prolific, both in the composition of the shell and the size of the aperture in relation to the diameter of the shell.

Penard (1902) described this species as having two distinct forms, the typical form and one varying between 135 and 155 μ. He also described two smaller forms 50 to 70 μ in size. Cash *et al.* (1909) described a small form (15–50 μ) under the name *D. globulus*, and suggested that Dujardin's original description of *D. globulosa* was ambiguous. In agreement with recent descriptions we have accepted Penard's (1902) re-description of *D. globulosa*.

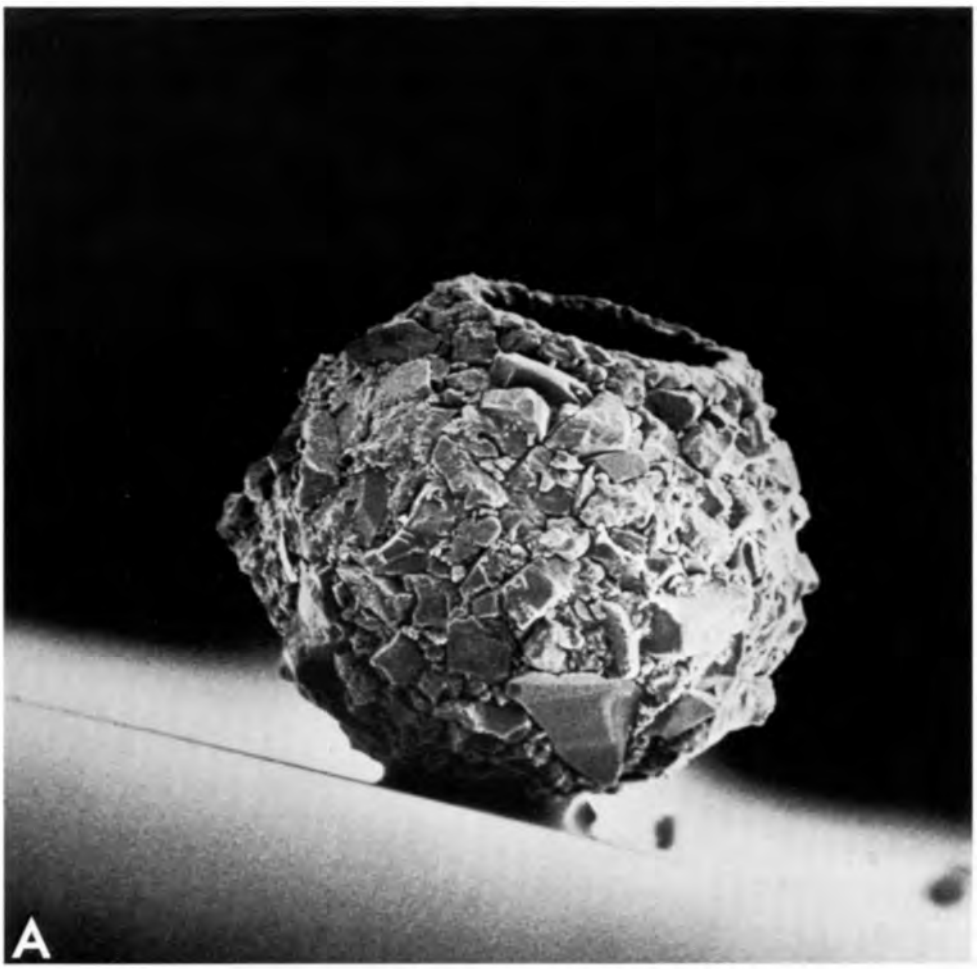
MEASUREMENTS (in μm)

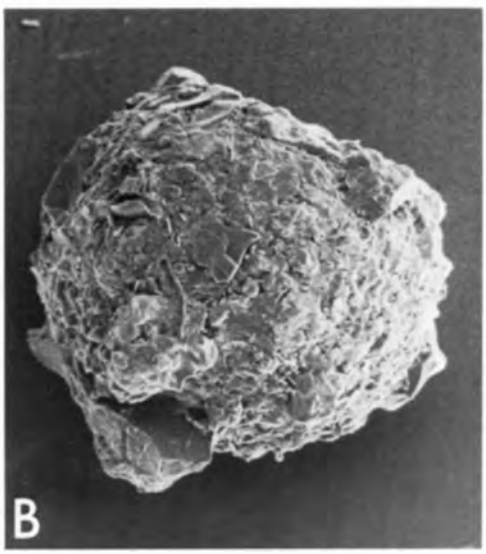
Author	Diameter of shell	Depth of shell	Diameter of aperture
Penard, 1902	70–100		
present work n = 13	91–119	79–113	33–58

GEOGRAPHICAL DISTRIBUTION Algeria, Austria, Belgium, Brazil, British Isles, Bulgaria, Congo, France, Germany, Iceland, Marion I., Poland, Roumania, Russia, South Africa, Sweden, Switzerland, United States of America, West Africa.

REFERENCES Boltovskoy & Lena, 1966, 1971, 1974; Chardez, 1961*a*; Chibisova, 1967; Decloitre, 1948, 1954, 1965; Gauthier-Lièvre & Thomas, 1958; Godenau *et al.*, 1973; Golemansky, 1970, 1974*b*; Green, 1975; Grospietch, 1971; Jung, 1936*a*; Laminger, 1972*a*, 1972*c*; Schönborn, 1975; Steineke, 1914; Štěpánek, 1963.

Fig. A Latero-apertural view × 610
Fig. B Lateral view × 460
Fig. C View of aperture × 440


A


B


C

Difflugia gramen Penard, 1902

DESCRIPTION The shell is brown or purplish-grey, spherical or ovoid (Fig. A). The surface is rough and covered with sand-grains, but like *D. corona* the gaps between large particles are often filled with smaller fragments. The aperture is trilobed (Fig. C) and is surrounded by a slightly raised collar of small particles cemented together (Fig. B).

The species varies in size and in the composition of the shell, according to Cash (1909) who stated that sometimes the shell was made of thin siliceous plates. Leidy (1879) described a specimen with five lobes surrounding the aperture, whereas Penard (1902) described both curved and rectangular shaped lobes.

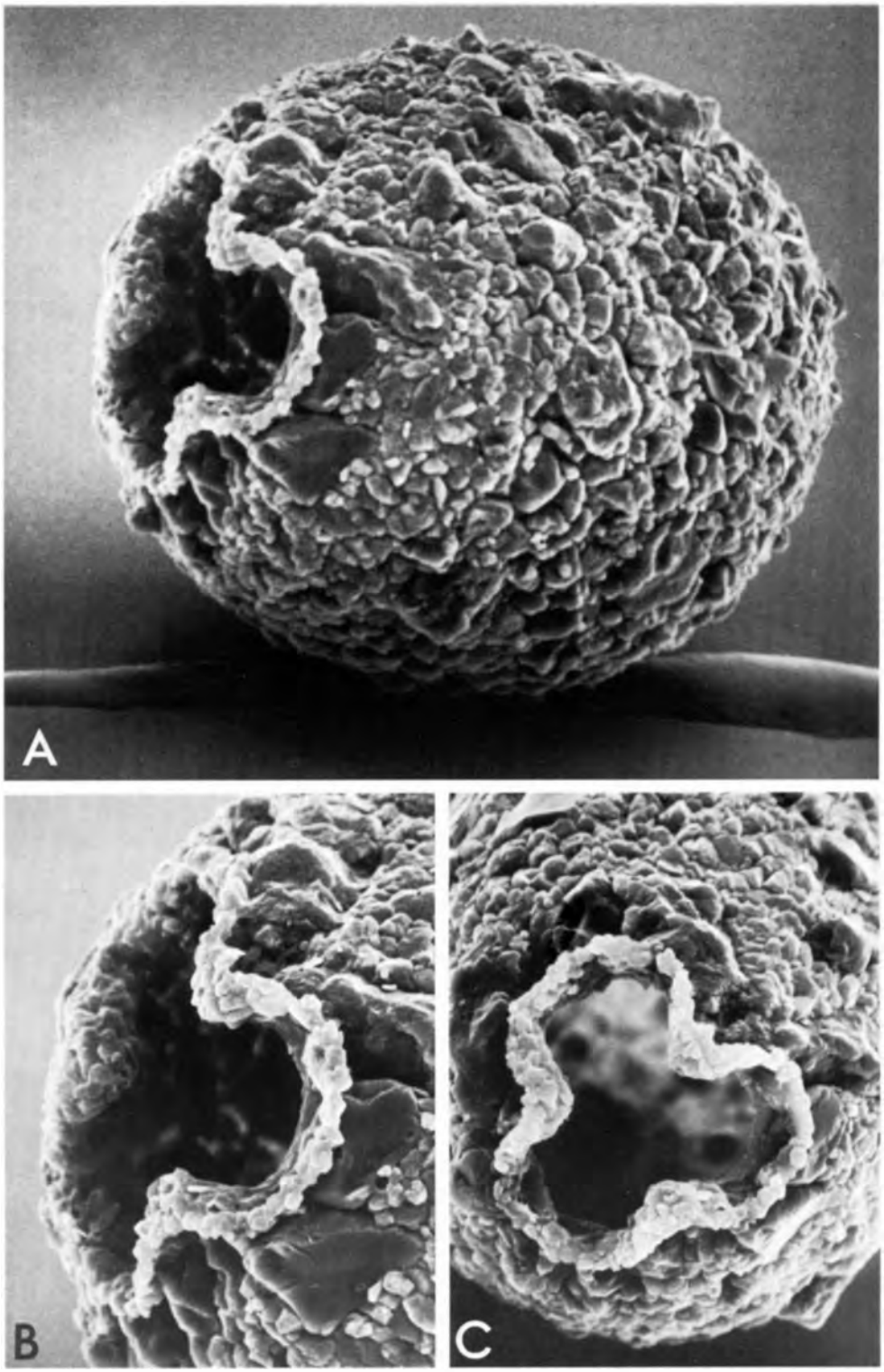
MEASUREMENTS (in μm)

Author	Length of shell	Breadth of shell	Diameter of aperture
Cash *et al.*, 1909	70	55–60	
present work n = 4	80–98	68–95	28–36

GEOGRAPHICAL DISTRIBUTION Algeria, Argentina, Australia, Austria, Belgium, Brazil, British Isles, Canada, Chile, Congo, Czechoslovakia, France, Germany, Hungary, Italy, Morocco, Poland, Roumania, Russia, Sunda I., Spain, Switzerland, Tunisia, United States of America, Venezuela, West Africa.

REFERENCES Boltovskoy & Lena, 1974; Chardez, 1961*a*; Deflandre, 1926; Gal, 1969; Gauthier-Lièvre & Thomas, 1958; Godenau *et al.*, 1973; Golemansky, 1970; Green, 1975; Grospietch, 1958*b*; Laminger, 1972*c*; Playfair, 1918; Vucetich, 1972.

Fig. A Latero-apertural view × 1250
Fig. B Side view of apertural collar to show the arrangement of small particles × 1700
Fig. C View of aperture × 1150


A
B
C

Difflugia labiosa Wailes, 1919

DESCRIPTION The shell is brown, ovoid with the apertural end truncate, and is composed of assorted quartz particles and diatom frustules (Figs. A and B). The aperture is surrounded by a shallow undulating lip, which may appear lobed, whilst the neck of the aperture is often recessed into the body of the shell (Figs. A and C).

This species can be distinguished from *D. amphoralis* Hopkinson, 1908 by the presence of a recess at the base of the neck.

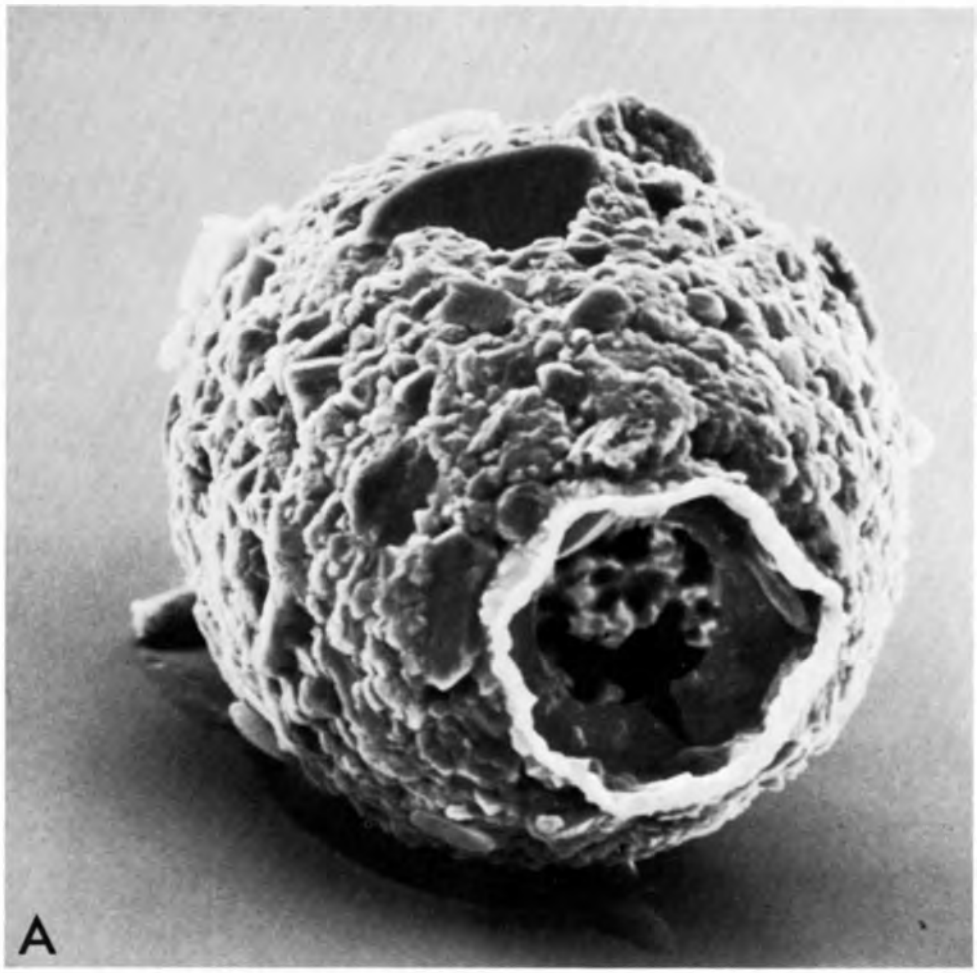
MEASUREMENTS (in μm)

Author	Length of shell	Breadth of shell	Diameter of aperture
Cash *et al.*, 1919	150–275	160	65
present work n = 1	158	118	52

GEOGRAPHICAL DISTRIBUTION Belgium, British Isles, Germany, Russia, Switzerland, United States of America, Venezuela.

REFERENCES Chardez, 1961*a*; Deflandre, 1926; Laminger, 1971.

Fig. A Apertural view × 760
Fig. B Lateral view × 420
Fig. C Detail of aperture × 780


A


B


C

Difflugia lanceolata Penard, 1890

DESCRIPTION The shell is yellow or hyaline, elongate and tapering at both ends (Fig. A). It is composed of siliceous angular particles arranged so that the sides appear polished and smooth (Figs. B, C and D). The aperture is circular and surrounded by an organic collar (Figs. B and C).

The shell may sometimes be more sharply pointed in the aboral region, but the clean outline of this species is the main distinguishing feature.

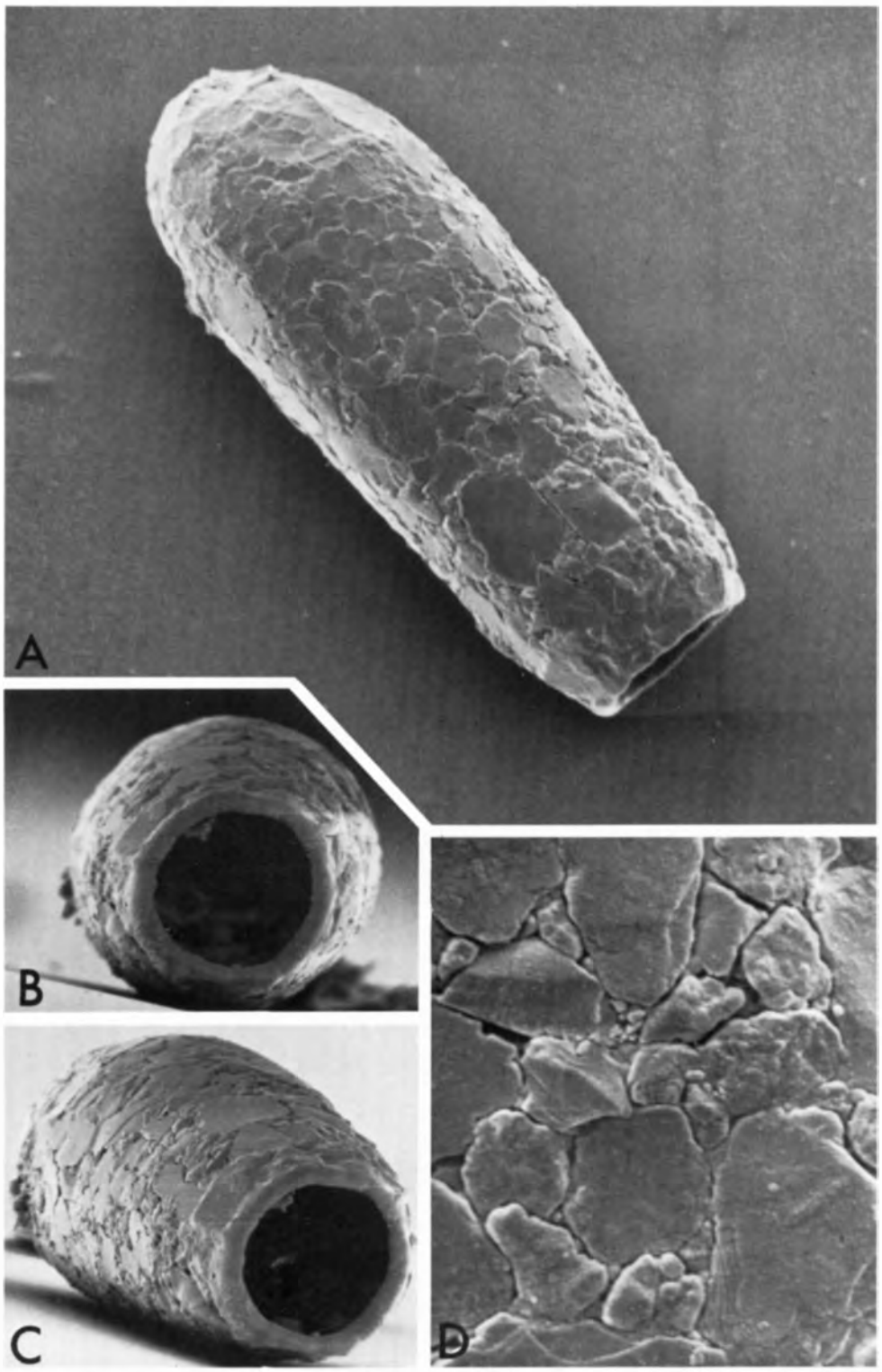
MEASUREMENTS (in μm)

Author	Length of shell	Breadth of shell	Diameter of aperture
Cash *et al.*, 1909	140–160		
present work n=4	116–159	46–72	23–28

GEOGRAPHICAL DISTRIBUTION Austria, Belgium, Brazil, British Isles, Bulgaria, Canada, China, Congo, Faroes, France, Germany, Hungary, Iceland, Java, Morocco, Roumania, Russia, Sunda I., Sweden, Switzerland, United States of America, Venezuela, West Africa.

REFERENCES Chardez, 1961*a*; Decloitre, 1954, 1965; Gal, 1969; Gauthier-Lièvre & Thomas, 1958; Godenau *et al.*, 1973; Green, 1975; Grospietch, 1975; Laminger, 1972*c*; Schönborn, 1975.

Fig. A Lateral view ×850
Fig. B Apertural view ×880
Fig. C View to show smooth outline of shell ×850
Fig. D The arrangement of siliceous particles in the shell ×3900


A
B
C
D

Difflugia lithophila Penard, 1902

DESCRIPTION The shell is brown, ovoid with a slight constriction near the aperture to form a small collar, and is circular in transverse section (Figs. A and B). It is composed of small quartz particles and some diatom shells. The aperture is circular and has an uneven outline (Figs. A and C).

Penard (1902) thought that the small collar of this species might easily be overlooked.

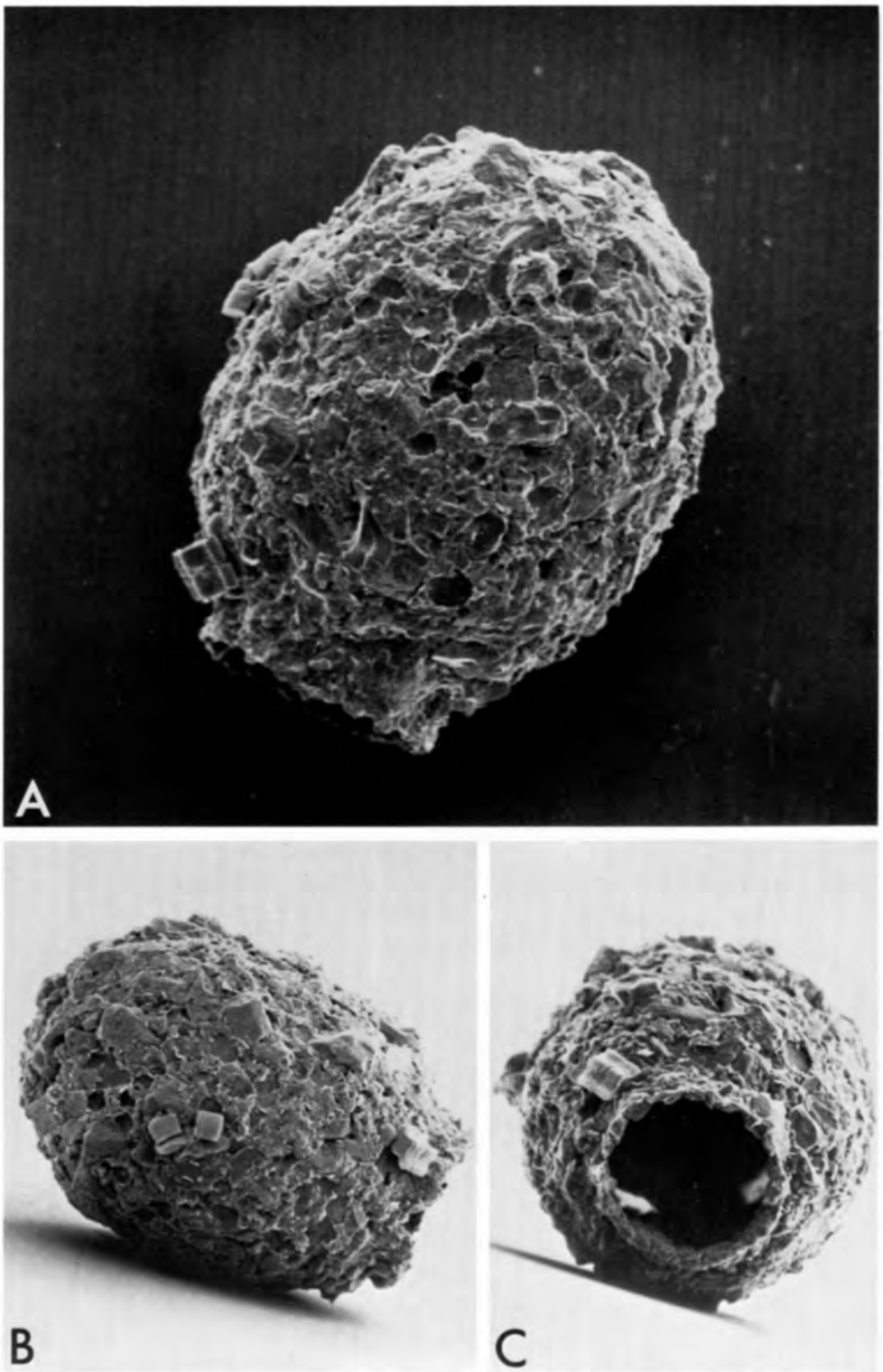
MEASUREMENTS (in μm)

Author	Length of shell	Breadth of shell	Diameter of aperture
Penard, 1902	100–140		
present work n = 1	126	99	47

GEOGRAPHICAL DISTRIBUTION Algeria, British Isles, France, Germany, Roumania, Sweden, Switzerland, Tunisia, West Africa.

REFERENCES Gauthier-Lièvre & Thomas, 1958; Godenau *et al.*, 1973; Schönborn, 1975.

Fig. A View to show small apertural collar × 690
Fig. B Lateral view × 480
Fig. C Apertural view × 490


A
B
C

Difflugia longicollis Gassowsky, 1936

DESCRIPTION The shell is brown, pyriform, the fundus is usually rounded and the neck tapers evenly to the aperture (Fig. A). The surface is rough and encrusted with sand-grains of various sizes (Figs. B, C and D). The aperture is circular and surrounded by a regular arrangement of small particles (Fig. E).

This species was considered by Gassowsky (1936) to be a variety of *D. oblonga* because of its small size. It is similar to *D. oblonga* (see p. 148) in shape, but we have found both species together in the same moss sample and have easily identified *D. longicollis* on size.

Note that the reports of this species by Gauthier-Lièvre & Thomas (1958) and Chardez (1967) are omitted because the measurements given (length 240–476 μ) are not comparable with the original description.

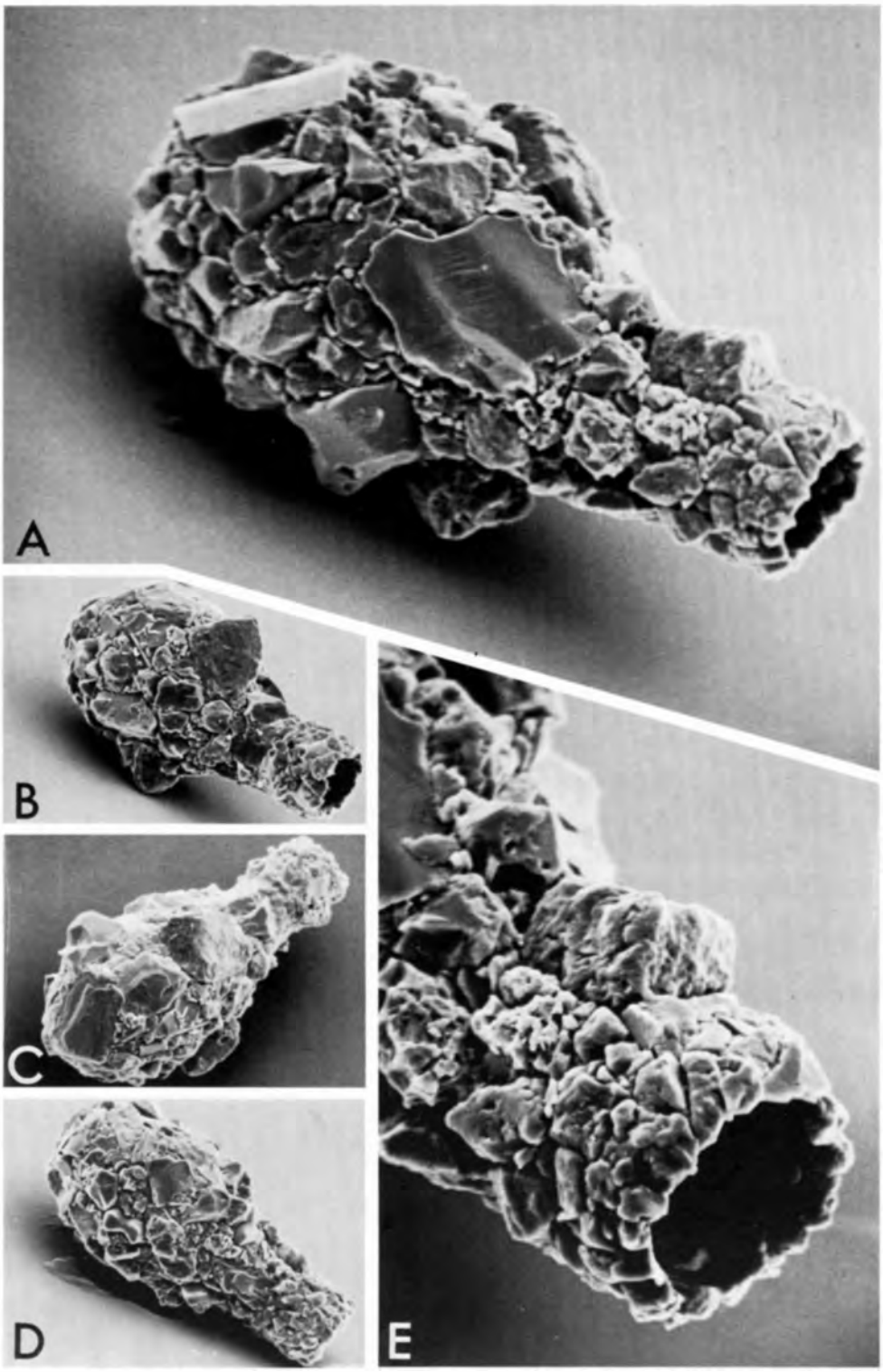
MEASUREMENTS (in μm)

Author	Length of shell	Breadth of shell	Diameter of aperture
Gassowsky, 1936	72–116	48–78	21–34
Margalef, 1955	108–120	35–40	15–16
present work n = 11	91–109	47–55	16–21

GEOGRAPHICAL DISTRIBUTION British Isles, France, Germany, Netherlands, Norway, Poland, Spain, United States of America.

REFERENCES Couteaux, 1969; Hoogenraad & Groot, 1940*b*; Margalef, 1955; Morcazewski, 1961; Voeltz-Höhn, 1971.

Fig. A Latero-apertural view × 1000
Figs. B, C and D Three separate species to illustrate shell shape × 470
Fig. E Detail of aperture × 1600


A
B
C
D
E

Difflugia manicata Penard, 1902

DESCRIPTION The shell is yellow or brown, oval, circular in transverse section and in the apical region tapers evenly to the aperture (Figs. A and C). It is covered with small sand grains which are usually packed closely together, but often the aboral region has a broken outline due to an addition of larger particles. The aperture is small, circular and usually surrounded by small particles, the regularity being occasionally broken by the inclusion of larger particles (Fig. B).

Variation appears to be restricted to the size of the materials used in shell formation.

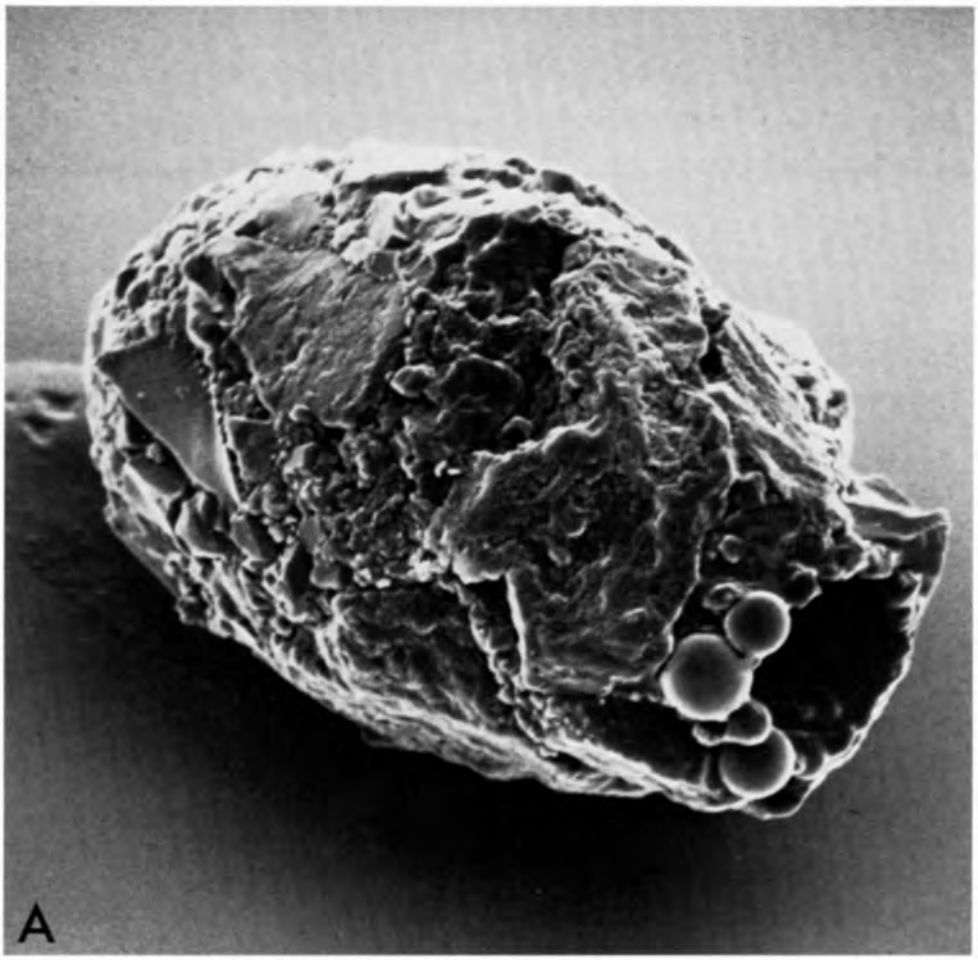
MEASUREMENTS (in μm)

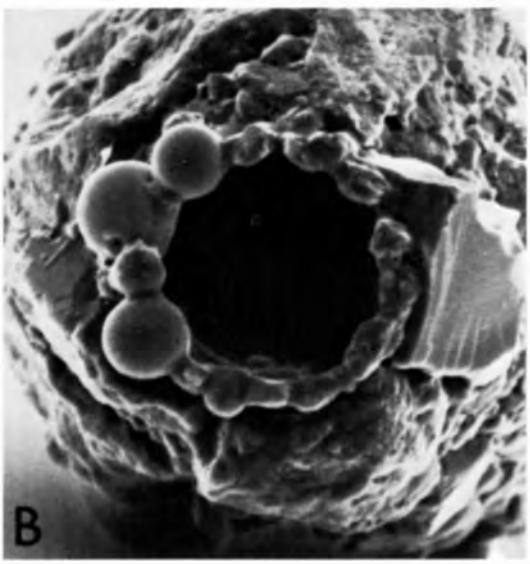
Author	Length of shell	Breadth of shell	Diameter of aperture
Cash *et al.*, 1919	60–80	40–53	20–27
present work n = 15	75–88	47–54	15–20

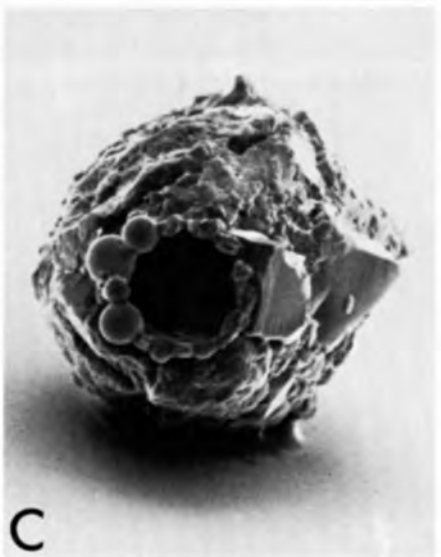
GEOGRAPHICAL DISTRIBUTION Austria, Belgium, British Isles, Congo, Germany, Russia, Switzerland.

REFERENCES Chardez, 1961*a*; Laminger, 1971, 1972*c*; Štěpánek, 1963.

Fig. A Lateral view × 1400
Fig. B Detail of aperture × 1600
Fig. C Apertural view × 800


A


B


C

Difflugia oblonga Ehrenberg, 1838

DESCRIPTION The shell is brown, pyriform and composed of quartz particles (Fig. A). The neck is often clearly defined (Fig. B) and the circular aperture is surrounded by small particles cemented together (Fig. C).

Several varieties were described by Penard (1890 and 1902) and Cash *et al.* (1909), which illustrate the considerable variation exhibited by this species. The description given by Cash appears to embrace several varieties described by Penard (1890), including *D. longicollis* (see p. 144), so we refer in the measurements to Penard's (1890) description. Nevertheless, the discussion given by Cash (1909) concerning the priority of the name *D. oblonga* over *D. pyriformis* of Perty (1849) is accepted.

MEASUREMENTS (in μm)

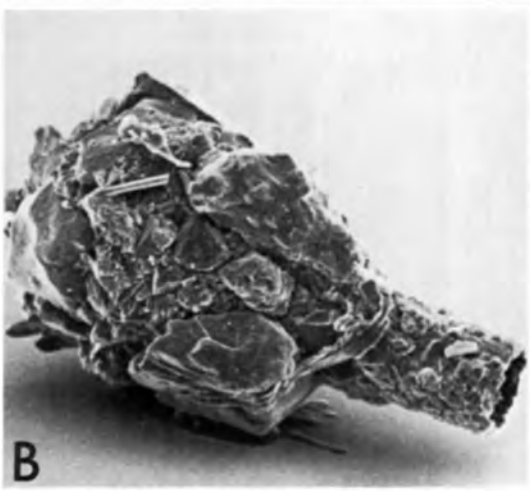
Author	Length of shell	Breadth of shell	Diameter of aperture
Penard, 1890	200–300	80–130	
present work n = 7	190–237	92–146	32–42

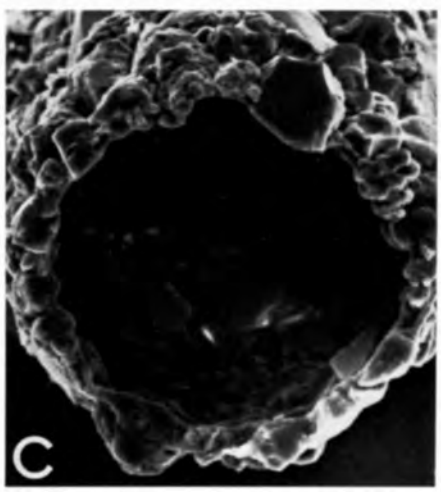
GEOGRAPHICAL DISTRIBUTION Algeria, Argentina, Austria, Belgium, Brazil, British Isles, Bulgaria, Canada, Chile, Czechoslovakia, Faroes, France, Germany, Iceland, Mexico, Morocco, Netherlands, Roumania, Russia, Spitzbergen, Sweden, Switzerland, Tunisia, United States of America, Venezuela, West Africa.

REFERENCES Boltovskoy & Lena, 1966, 1971, 1974; Bonnet, 1966; Chardez, 1961*a*; Chibisova, 1967; Chardez & Decloitre, 1973; Decloitre, 1965, 1966; Deflandre, 1926; Gauthier-Lièvre & Thomas, 1958; Godenau *et al.*, 1973; Golemansky, 1974*b*; Green, 1975; Jung, 1963*a*; Laminger, 1972*c*, 1973*b*, 1975; Puytorac *et al.*, 1972; Schönborn, 1975; Steineke, 1914; Štěpánek, 1963, 1967.

Fig. A Latero-apertural view × 620
Fig. B Lateral view × 280
Fig. C View of aperture × 1200


A


B


C

Difflugia oviformis Cash, 1909

DESCRIPTION The shell is light brown, sub-spherical or ovoid, tapering evenly to the aperture (Figs. A, B and C). It is composed of small siliceous elements, and occasionally some diatom shells, irregularly arranged and bound by cement to produce a smooth surface (Figs. A and B). Small pores are often seen in the cement between adjacent elements (Fig. D). The aperture is surrounded by a thick collar of organic cement, which divides the opening into either three or four lobes (Figs. A and B).

Specimens with five or six lobes surrounding the aperture have been reported (Chardez, 1967). The arrangement of siliceous elements to produce a daughter cell at division have been described by Netzel (1976*b*, 1977).

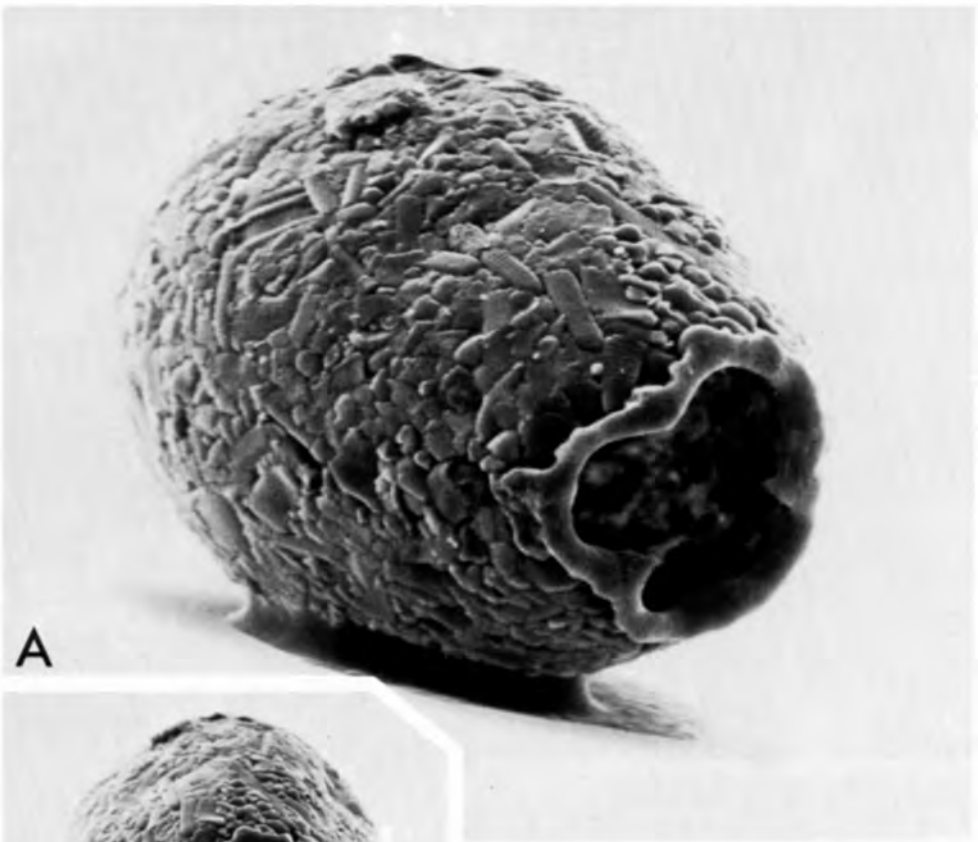
MEASUREMENTS (in μm)

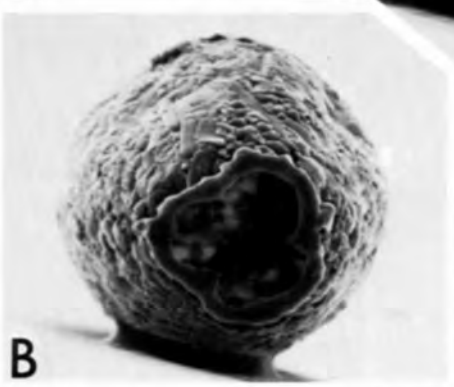
Author	Length of shell	Breadth of shell	Diameter of aperture
Cash *et al.*, 1909	110	80	
Chardez, 1967	60–120	30–90	15–30
present work n = 4	79–87	57–67	25–26

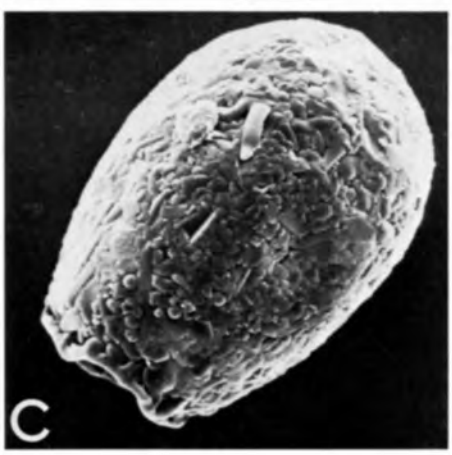
GEOGRAPHICAL DISTRIBUTION Algeria, Austria, Australia, Belgium, British Isles, Germany, Netherlands, Poland, Russia, South Africa, United States of America.

REFERENCES Chardez, 1961*a*, 1967; Gauthier-Lièvre & Thomas, 1958; Hoogenraad & Groot, 1940*b*; Laminger, 1972*c*; Netzel, 1972, 1976*b*, 1977.

Fig. A Latero-apertural view × 1400
Fig. B Apertural view × 780
Fig. C Lateral view × 730
Fig. D Portion of shell surface × 4700


A


B


C


D

Difflugia penardi Hopkinson, 1909

DESCRIPTION The shell is transparent or yellow, ovoid and circular in transverse section (Figs. A and D). It is thin, usually has a regular outline, and is composed mainly of small diatom frustules arranged on an organic matrix (Fig. B). Although the major part of the shell is made of specimens belonging to the diatom genera *Cocconeis* and *Achnanthes*, larger diatom shells and spherical siliceous cysts of chrysomonad flagellates may also be incorporated (Figs. A and D). The aperture is small and circular (Fig. C).

This species was initially described under the name *D. fallax* by Penard (1890), who suggested that the animal may have made the siliceous plates. It would appear from our observations that the density of the organic cement masks the fine detail of the diatom frustules, but emphasises the outlines so that they seem to be siliceous plates.

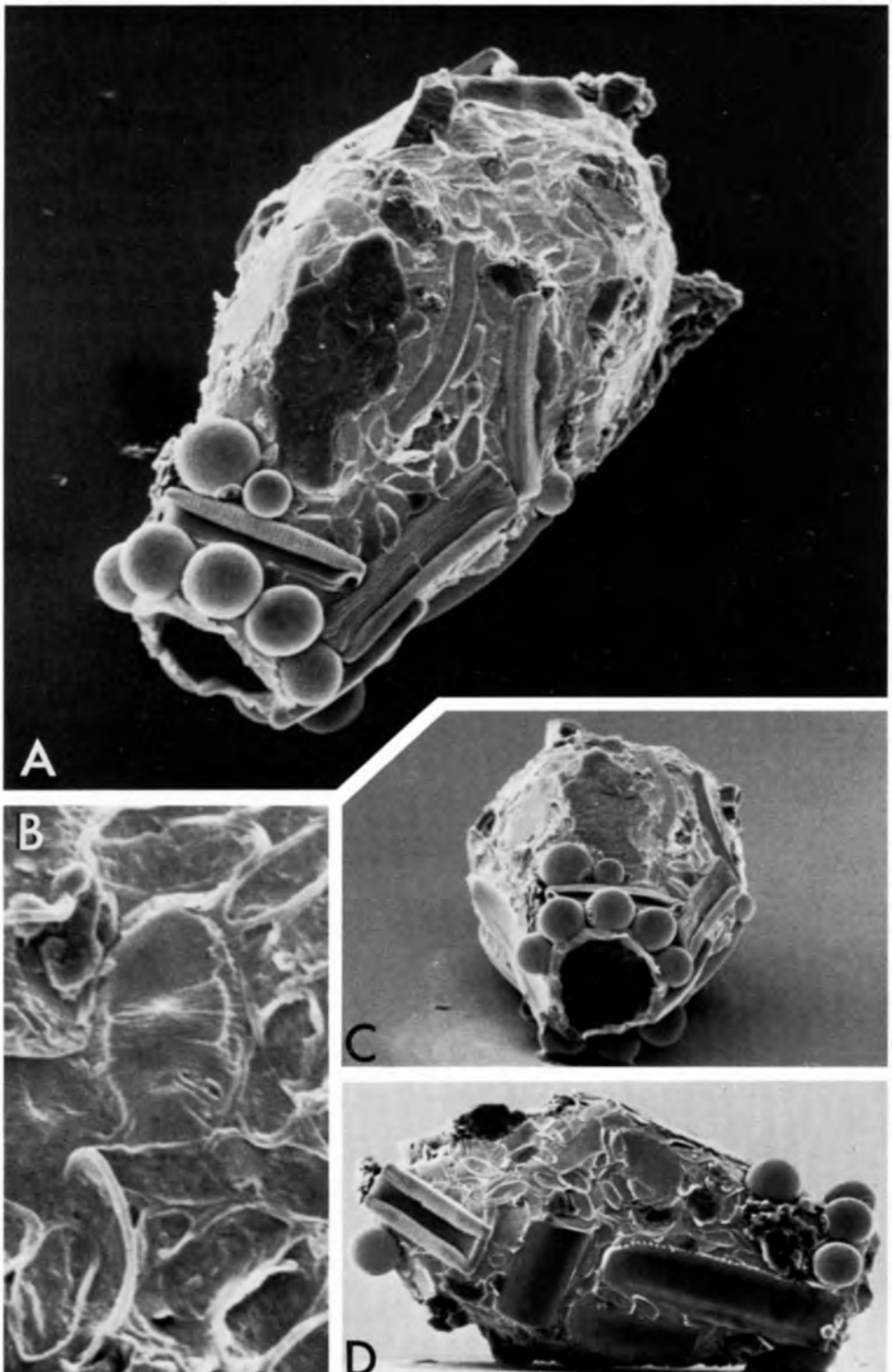
MEASUREMENTS (in μm)

Author	Length of shell	Breadth of shell	Diameter of aperture
Cash *et al.*, 1909	60–85	30	
present work n = 4	75–94	47–54	17–19

GEOGRAPHICAL DISTRIBUTION Algeria, Australia, Austria, Belgium, Brazil, British Isles, Bulgaria, Canada, Chile, France, Germany, Nepal, Poland, Russia, Signy I., South Africa, Sweden, Switzerland, United States of America, Venezuela, West Africa.

REFERENCES Chardez, 1961*a*; Chibisova, 1967; Deflandre, 1926; Gauthier-Lièvre & Thomas, 1958; Golemansky, 1970, 1974*b*; Green, 1975; Laminger, 1972*a*, 1972*b*, 1972*c*; Playfair, 1918; Schönborn, 1975; Smith, 1973*a*.

Fig. A Latero-apertural view × 1300
Fig. B Portion of shell × 4500
Fig. C Apertural view × 790
Fig. D Lateral view × 820


A
B
C
D

Difflugia rubescens Penard, 1891

DESCRIPTION The shell is yellow or light brown, pyriform (Figs. A and B). It is usually encrusted with sand-grains or diatom frustules. The aperture is circular and bordered by an organic collar, the inner margin of which is crenulated to form tooth-like structures (Figs. A and C).

The outer covering of this species varies considerably in having either few or numerous diatom-frustules attached to the shell, often to the extent that they disguise the pyriform shape.

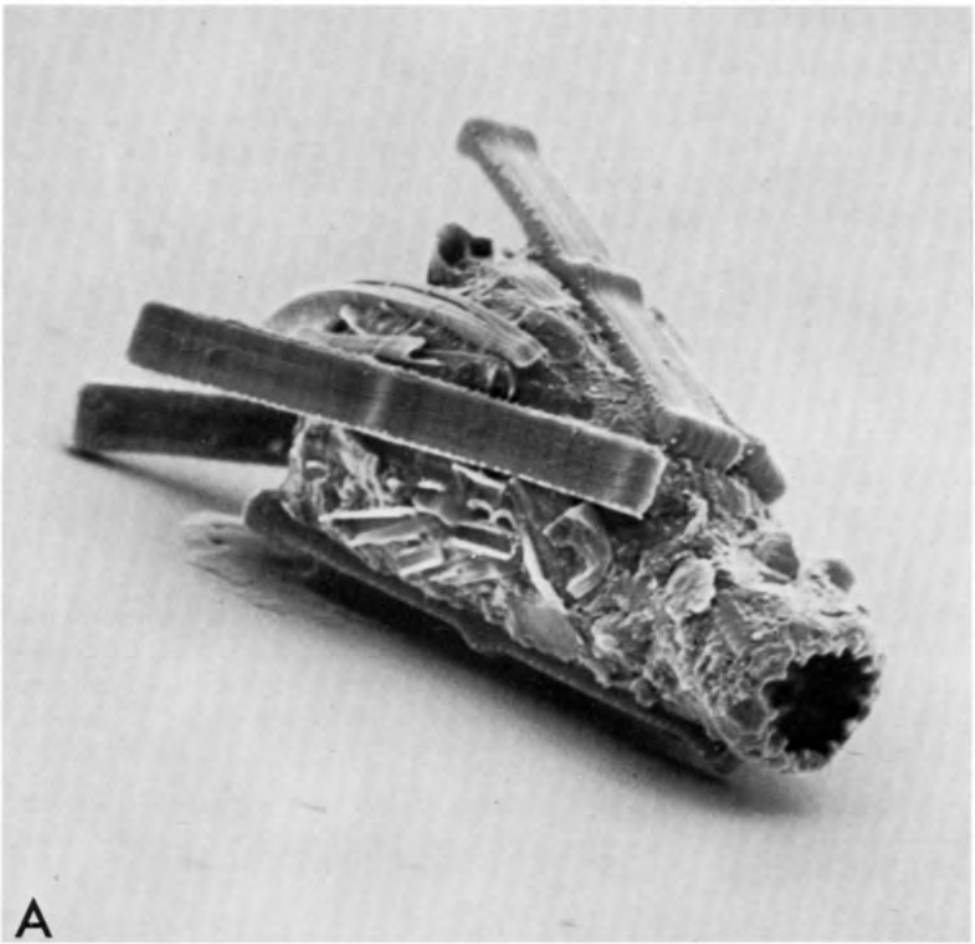
MEASUREMENTS (in μm)

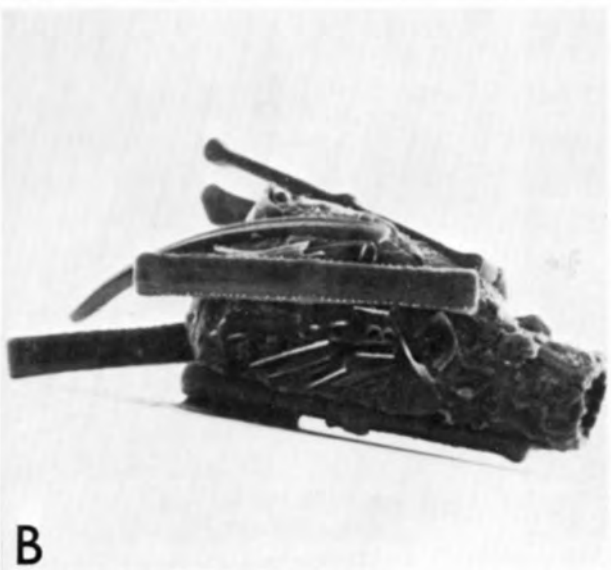
Author	Length of shell	Breadth of shell	Diameter of aperture
Cash *et al.*, 1919	66–105	42–70	16–30
present work n = 11	70–91	38–54	14–20

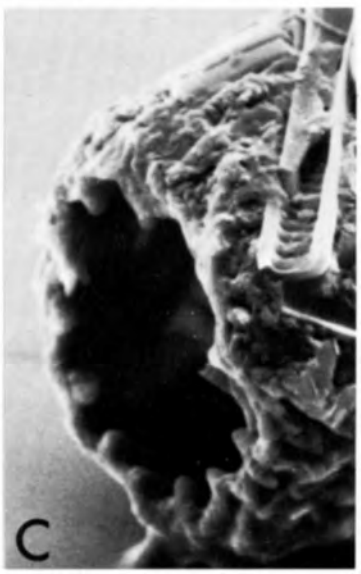
GEOGRAPHICAL DISTRIBUTION Austria, Belgium, British Isles, Bulgaria, Canada, Czechoslovakia, France, Germany, Netherlands, Poland, Russia, Sweden, Switzerland, United States of America, West Africa.

REFERENCES Chardez, 1961*a*; Decloitre, 1954; Graaf, 1956; Golemansky, 1970, 1974*b*; Jung, 1936*a*; Laminger, 1972*c*, 1975; Schönborn, 1975; Steineke, 1914.

Fig. A Latero-apertural view × 900
Fig. B Lateral view × 550
Fig. C Detail of aperture × 2500


A


B


C

Difflugia tuberculata (Wallich, 1864)

DESCRIPTION The shell is brown, ovoid or circular and composed of quartz particles (Fig. A). The surface is characterized by having an almost regular arrangement of small protrubences, which are composed of aggregates of small particles (Figs A, B and C). The aperture is circular and is bordered by a narrow collar of small pieces of quartz (Fig. B).

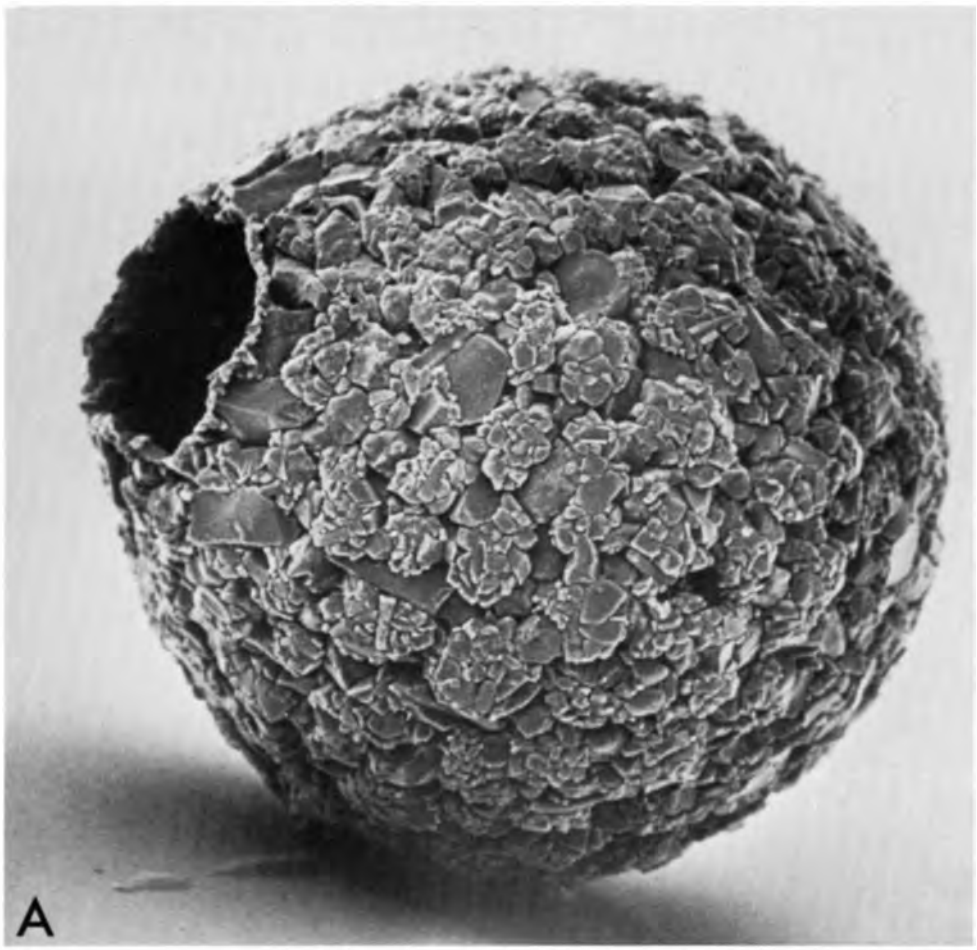
MEASUREMENTS (in μm)

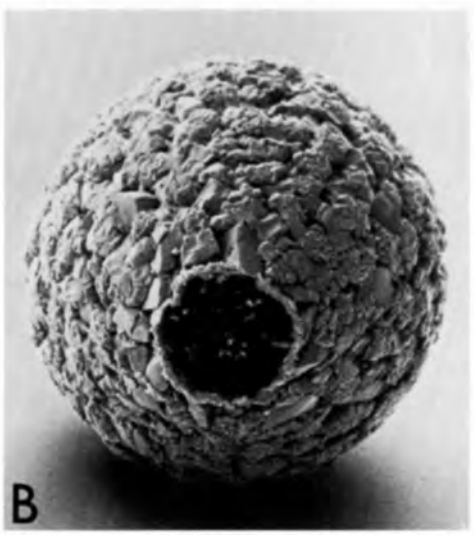
Author	Length of shell	Breadth of shell	Diameter of aperture
Cash *et al.*, 1909	avg. 130		
present work n = 6	102–140	98–140	39–44

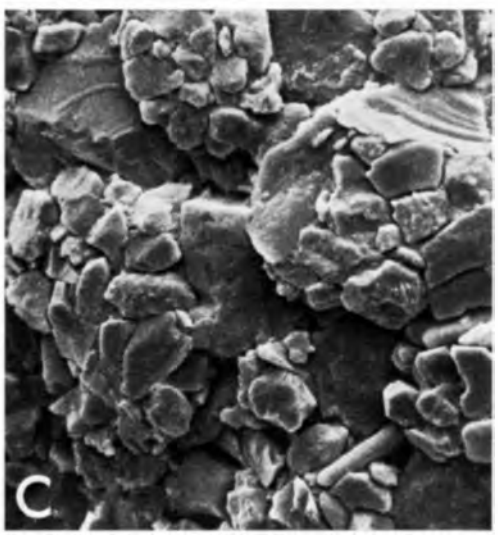
GEOGRAPHICAL DISTRIBUTION Algeria, Argentina, Australia, Belgium, Brazil, British Isles, Bulgaria, Canada, Chile, Colombia, Congo, Costa Rica, Czechoslovakia, East Africa, France, Germany, Hungary, Iceland, Italy, Japan, Luxembourg, Poland, Roumania, Russia, Sunda I., Switzerland, United States of America, Venezuela, West Africa.

REFERENCES Chardez, 1961*a*; Decloitre, 1965; Deflandre, 1926; Gauthier-Lièvre & Thomas, 1958; Godenau *et al.*, 1973; Golemansky, 1970, 1974*b*; Štěpánek, 1963; Vucetich, 1972.

Fig. A Latero-apertural view × 720
Fig. B Apertural view × 370
Fig. C Portion of shell × 1600


A


B


C

Difflugia urceolata Carter, 1864

DESCRIPTION The shell is opaque, ovoid or circular, with irregular, blunt, aboral protruberances and a pronounced apical rim or collar (Figs. A and B). It is composed of assorted sand grains to give a relatively smooth and regular outline. The aperture is circular with the surrounding rim made of small quartz particles cemented together to form a regular structure (Figs. C and D).

Variation in this species appears to be restricted to the presence or absence of aboral spines, and differences in size.

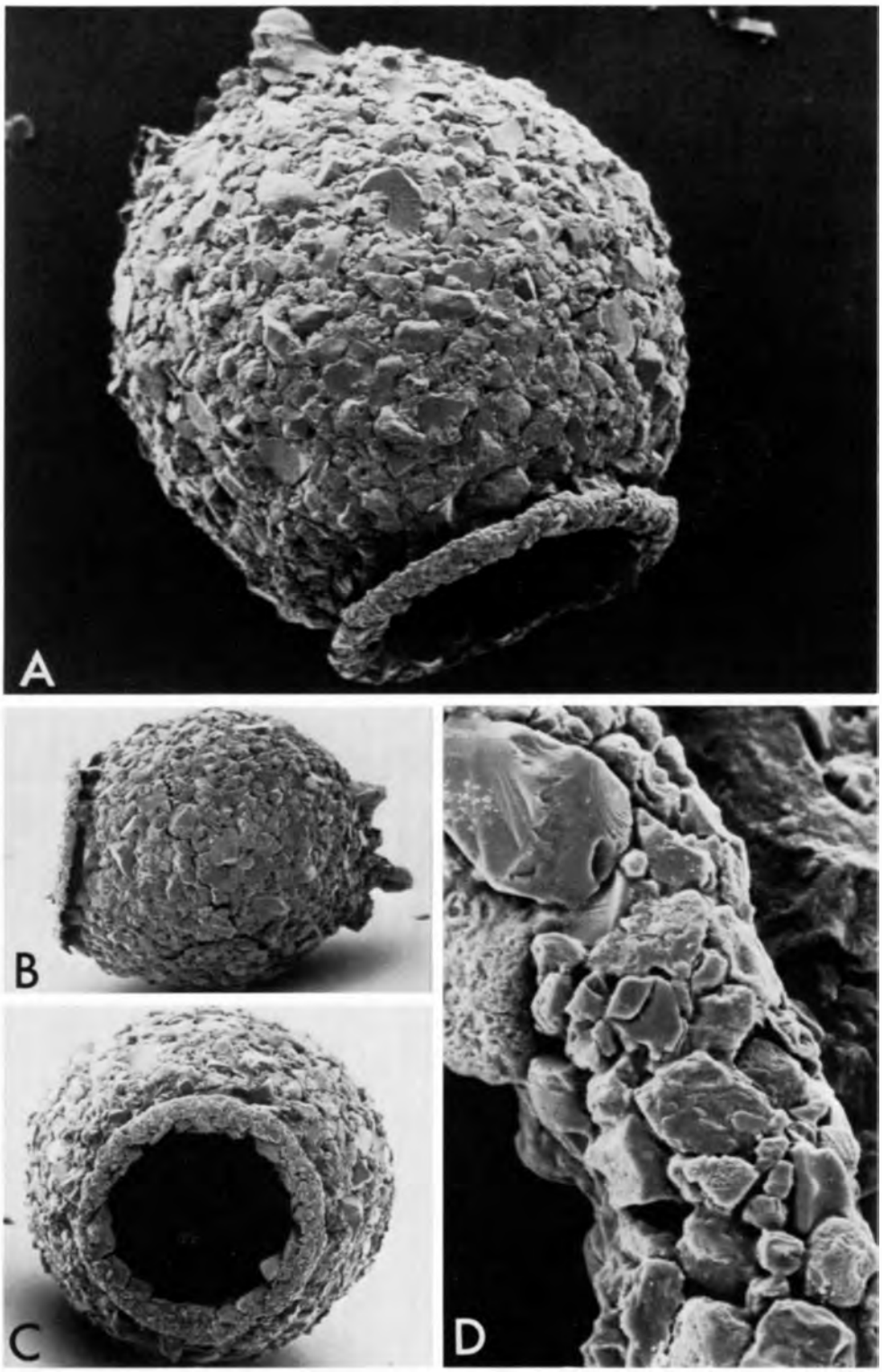
MEASUREMENTS (in μm)

Author	Length of shell	Breadth of shell	Diameter of aperture
Cash *et al.*, 1909	220–230	150–200	
present work n = 4	313–394	250–426	122–198

GEOGRAPHICAL DISTRIBUTION Algeria, Argentina, Australia, Austria, Belgium, Brazil, British Isles, Canada, Chile, China, Congo, Finland, France, Germany, Italy, Mexico, Netherlands, Paraguay, Russia, Switzerland, United States of America, Venezuela, West Africa.

REFERENCES Boltovskoy & Lena, 1966, 1971, 1974; Chardez, 1961*a*; Decloitre, 1954; Deflandre, 1926; Gauthier-Lièvre & Thomas, 1958; Green, 1975; Laminger, 1972*c*; Playfair, 1918; Steineke, 1914; Štěpánek, 1963.

Fig. A Latero-apertural view × 190
Fig. B Lateral view × 90
Fig. C Apertural view × 130
Fig. D Portion of apertural collar × 1300


A
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D

Difflugia viscidula Penard, 1902

DESCRIPTION The shell is opaque, ovoid, elongate and circular in transverse section (Figs. A, B and D). It is composed of a mixture of large and small particles of quartz (Fig. C). The aperture is circular, has a regular outline and is surrounded by small particles (Fig. B).

This species was originally described from depths of 20 to 40 metres in Lake Geneva by Penard (1902), who considered it to have a fragile shell. Our specimens, are robust, but otherwise agree well with his description.

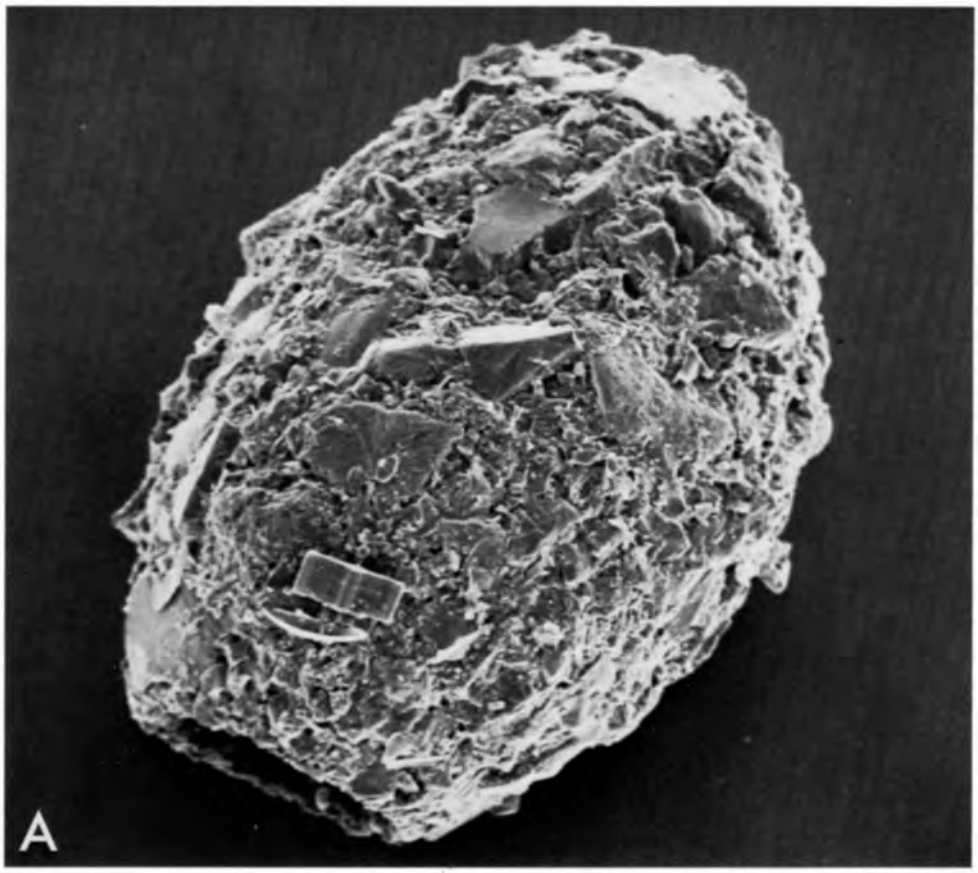
MEASUREMENTS (in μm)

Author	Length of shell	Breadth of shell	Diameter of aperture
Penard, 1902	180–260		
present work n = 5	256–284	188–215	82–89

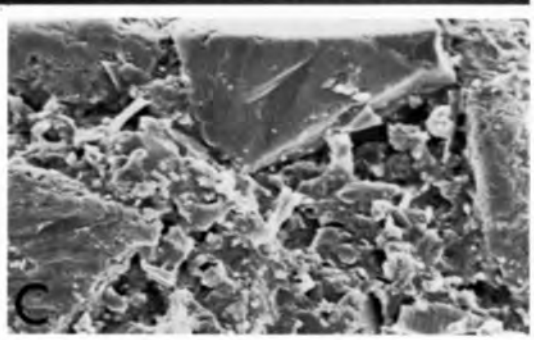
GEOGRAPHICAL DISTRIBUTION Argentina, Austria, British Isles, Roumania, Sweden, Switzerland.

REFERENCES Boltovskoy & Lena, 1974; Godenau *et al.*, 1973; Laminger, 1971; Schönborn, 1975.

Fig. A Latero-apertural view × 460
Fig. B Apertural view × 230
Fig. C Portion of shell × 880
Fig. D Lateral view × 180


A


B


C


D

Pontigulasia compressa (Carter, 1864)

DESCRIPTION The shell is brown, ovoid or pyriform, with a short neck that joins the body in a V-shaped wedge (Figs. A and B). Convex protruberances arise from each arm of the V-shaped wedge to give this species its characteristic shape. In lateral view it is compressed (Fig. D). It has a rough surface composed of different sizes of sand- or quartz-grains arranged on an organic matrix (Fig. C). The aperture is circular or ovoid (Fig. B), and internally at the junction of the neck is a perforated diaphragm.

This species varies considerably in size and in the composition of the shell, often large particles are used to construct the shell and mask the characteristic outline of the convex protruberances.

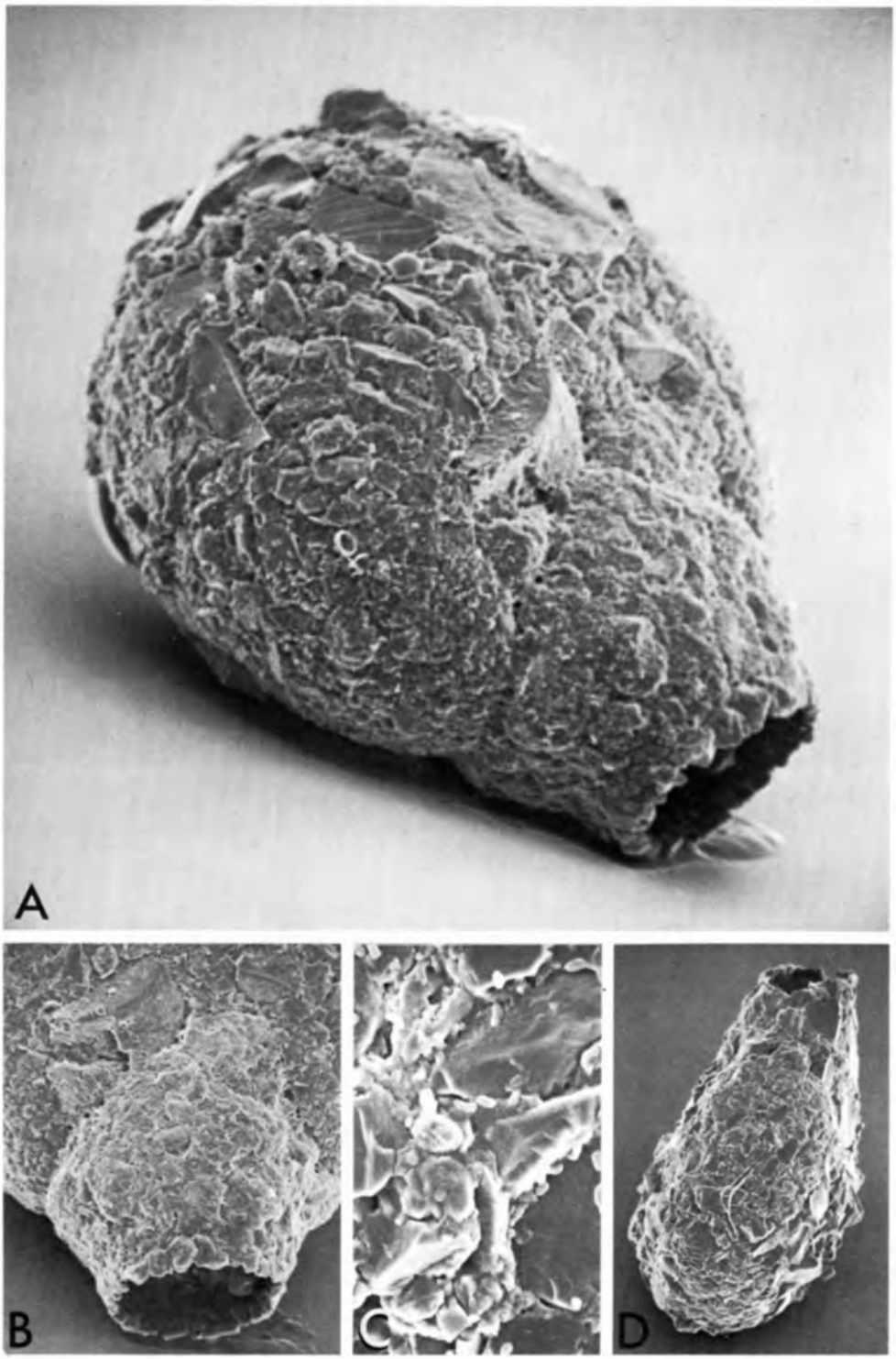
MEASUREMENTS (in μm)

Author	Length of shell	Breadth of shell	Depth of shell	Diameter of aperture
Cash *et al.*, 1909	130–150	100		
present work n = 17	196–289	166–222	107–179	45–75

GEOGRAPHICAL DISTRIBUTION Argentina, Austria, Belgium, British Isles, France, Germany, Roumania, Sweden, Switzerland, Venezuela.

REFERENCES Boltovskoy & Lena, 1974; Chardez, 1961*a*; Godenau *et al.*, 1973; Grospietch, 1958*b*, 1975; Laminger, 1975; Schönborn, 1975.

Fig. A Latero-apertural view × 470
Fig. B View to show aperture and V-shaped wedge of neck × 330
Fig. C Portion of shell surface × 1250
Fig. D Lateral view × 190


A
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Pontigulasia elisa (Penard, 1893)

DESCRIPTION The shell is brown, pyriform with a distinct constriction to form a neck region, and it is oval or circular in transverse section (Figs. A, C and D). It has a rough surface which is composed mainly of sand grains. The aperture is circular, and surrounded by an irregular arrangement of small sand particles (Figs. B and C). An internal, perforated, diaphragm is present across the neck, at the junction of the neck with the main body.

Penard (1902) describes four species with distinct necks: *P. incisa* (=*P. elisa*); *P. bryophila*; *P. spectabilis* (=*P. vas*) and *P. spiralis*, all having the same range of size, but differing in structure and also the form of the internal diaphragm.

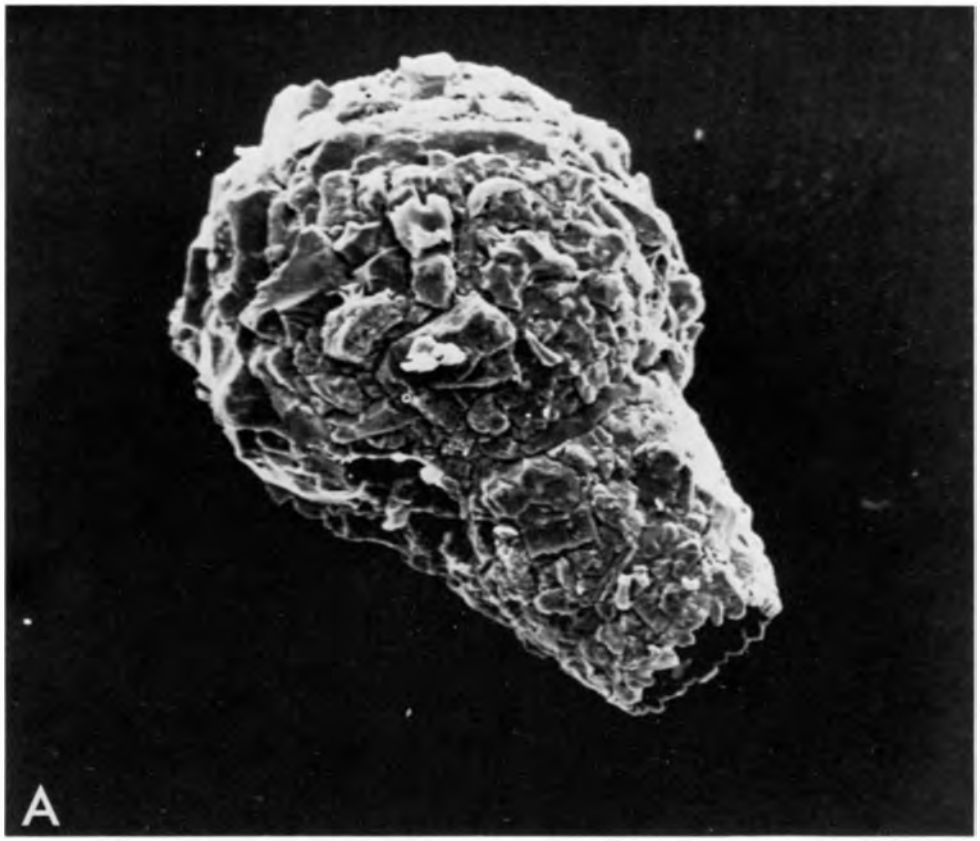
MEASUREMENTS (in μm)

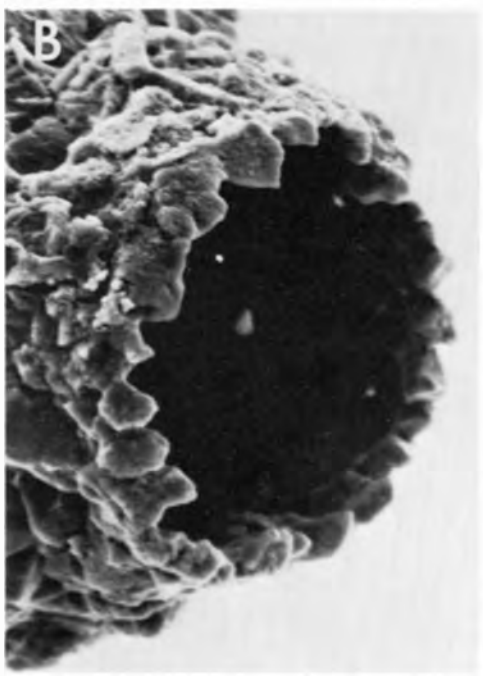
Author	Length of shell	Breadth of shell	Depth of shell	Diameter of aperture
Penard, 1902	85–120			
Cash *et al.*, 1909	85–150			
present work n=3	118–144	80–92	74–84	29–35

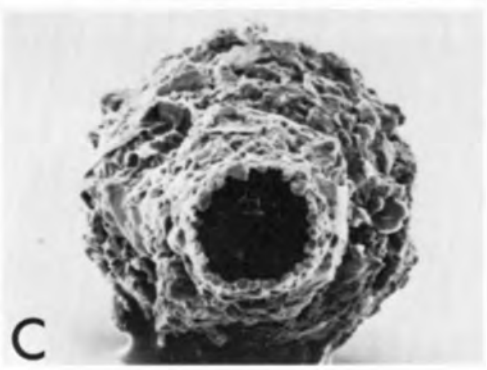
GEOGRAPHICAL DISTRIBUTION Austria, Belgium, British Isles, France, Germany, Russia, Switzerland.

REFERENCES Chardez, 1961*a*; Chibisova, 1967; Laminger, 1972*c*.

Fig. A Latero-apertural ×770
Fig. B View of aperture ×1900
Fig. C Apertural view ×460
Fig. D Lateral view ×410


A


B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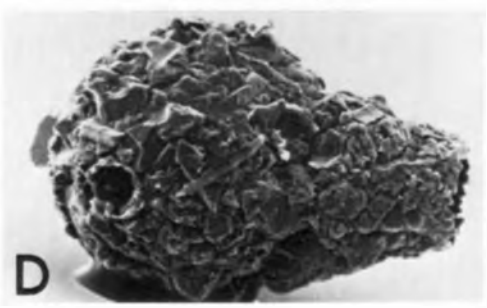

D

Cryptodifflugia oviformis Penard, 1890

DESCRIPTION The shell is colourless, circular or ovoid, and has a smooth surface (Fig. A). The shell wall is composed of two layers, a thin outer covering of organic material and a thick inner layer of amorphous calcium phosphate. The aperture is terminal, round and bordered by a small organic collar (Figs. B and C).

Abnormal forms occur in clonal cultures. These are usually two or three times the size of a normal animal, have two or more apertures and often have an uneven surface (Hedley *et al.*, 1977).

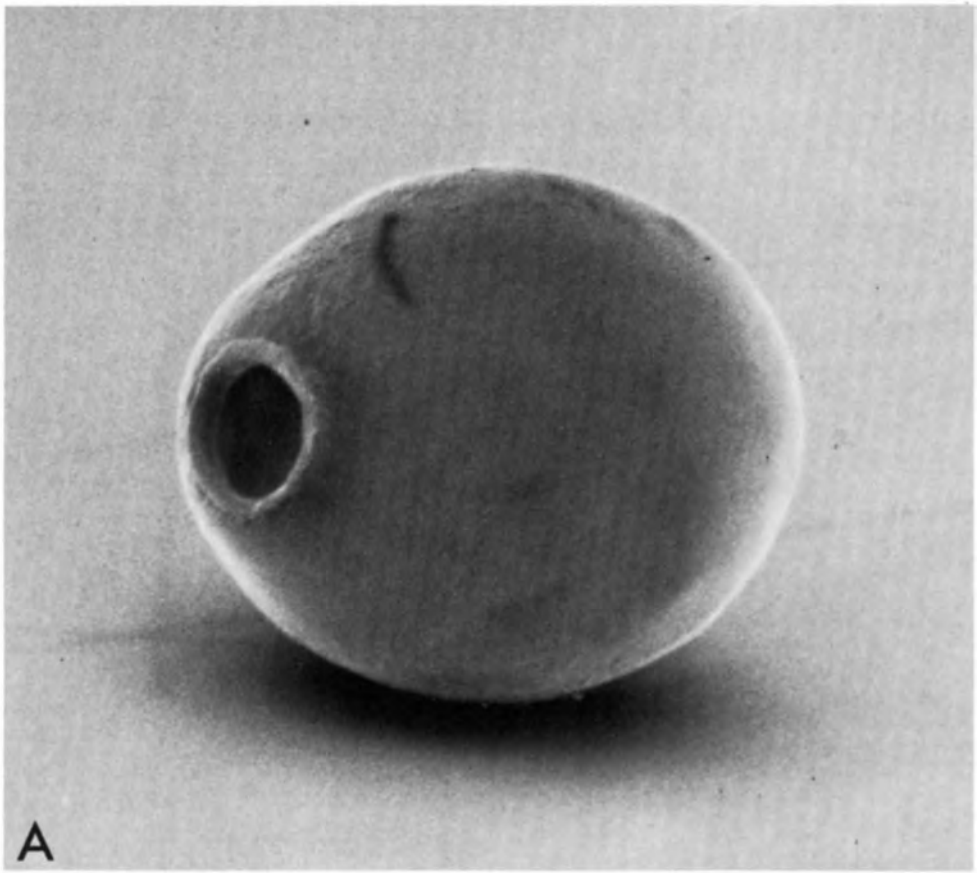
MEASUREMENTS (in μm)

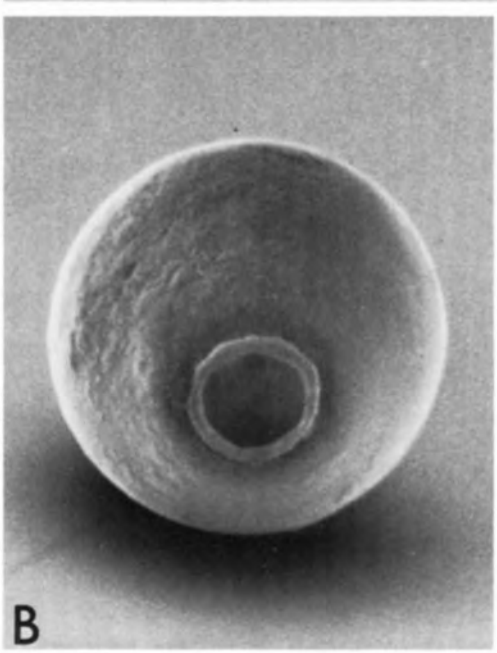
Author	Length of shell	Breadth of shell	Diameter of aperture
Cash *et al.*, 1909	16–20	12–15	
Bonnet and Thomas, 1960	13–26	8–15	3–5
Hedley *et al.*, 1977 n = 100	14·5–22·2	12.8–17.6	3.2–6.4

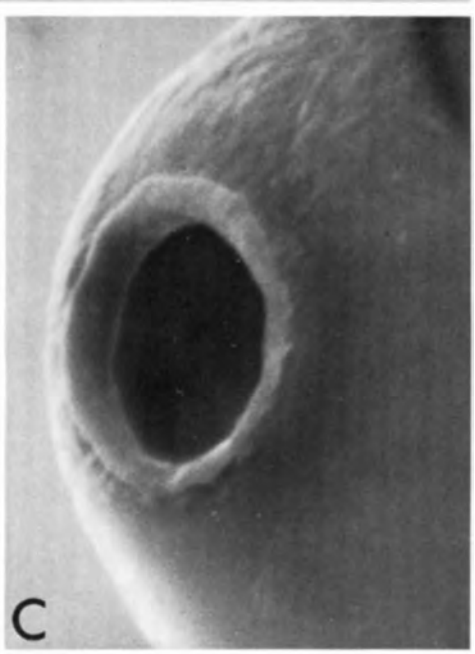
GEOGRAPHICAL DISTRIBUTION Angola, Australia, Austria, Belgium, British Isles, Bulgaria, Canada, Chile, Colombia, Congo, Czechoslovakia, France, Germany, Greece, Hungary, Iceland, Italy, Marion I., Netherlands, New Zealand, Poland, Roumania, Russia, Sunda I., Sweden, Switzerland, United States of America, West Africa.

REFERENCES Bonnet, 1960, 1966, 1967*b*; Bonnet & Thomas, 1960; Chardez, 1961*a*; Decloitre, 1965; Godenau *et al.*, 1973; Golemansky, 1970; Grospietch, 1964, 1971; Hedley *et al.*, 1977; Jung, 1936*a*; Laminger, 1972*a*, 1975; Lousier, 1976; Štěpánek, 1963; Thomas, 1959.

Fig. A Latero-apertural view × 5100
Fig. B Apertural view × 3000
Fig. C Lateral view of aperture to illustrate the apertural collar × 8400


A


B


C

Phryganella nidulus Penard, 1902

DESCRIPTION The shell is opaque, large, circular and hemispherical in lateral view (Figs. A and B). It is composed of a mixture of quartz particles and diatom frustules, the distribution of a few large particles in this mixture contributes to the irregular outline of the shell and aperture. The aperture is concentric and slightly invaginated (Figs. A, C and D).

Three specimens are shown to demonstrate the variation in size and shape of this species.

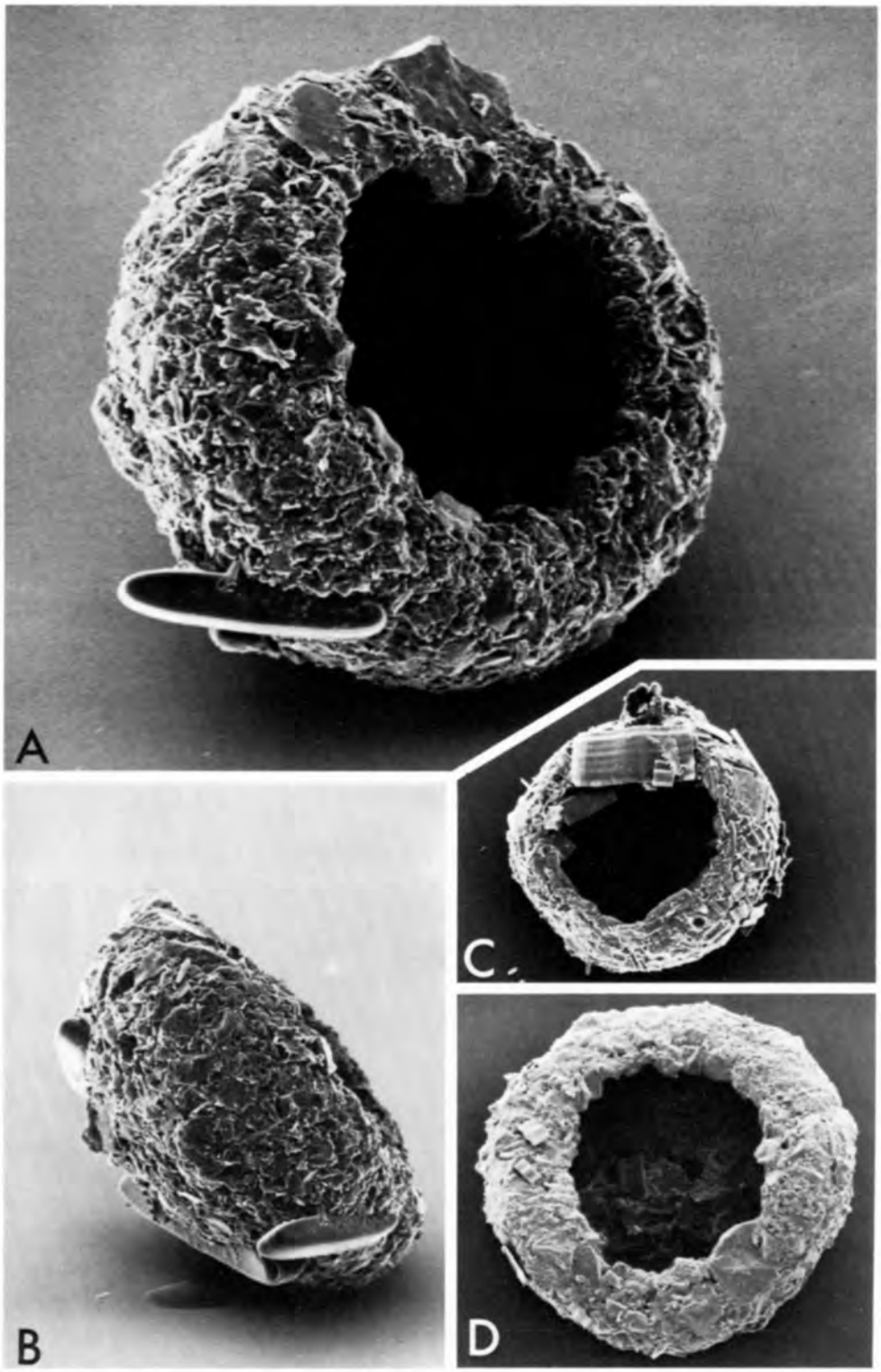
MEASUREMENTS (in μm)

Author	Diameter of shell	Depth of shell	Diameter of aperture
Penard, 1902	165–220		
present work n = 5	171–356	89–157	93–187

GEOGRAPHICAL DISTRIBUTION Austria, British Isles, Canada, France, Germany, Java, Russia, Sumatra, Switzerland, Venezuela, United States of America.

REFERENCES Godeanu *et al.*, 1973; Grospietch, 1975; Hoogenraad & Groot, 1940*a*; Laminger, 1972*c*, 1975; Puytorac *et al.*, 1972; Steineke, 1914.

Fig. A Latero-apertural view × 310
Fig. B Lateral view × 220
Fig. C Apertural view (specimen 2) × 140
Fig. D Apertural view (specimen 3) × 140


A
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Phryganella paradoxa Penard, 1902

DESCRIPTION The shell is colourless or yellow, ovoid and circular in transverse section (Figs. A and C). The walls are thin and composed of small siliceous plates and some pieces of diatom frustules (Fig. B). The aperture is usually circular (Fig. C), but because of the thin walls it may sometimes be distorted.

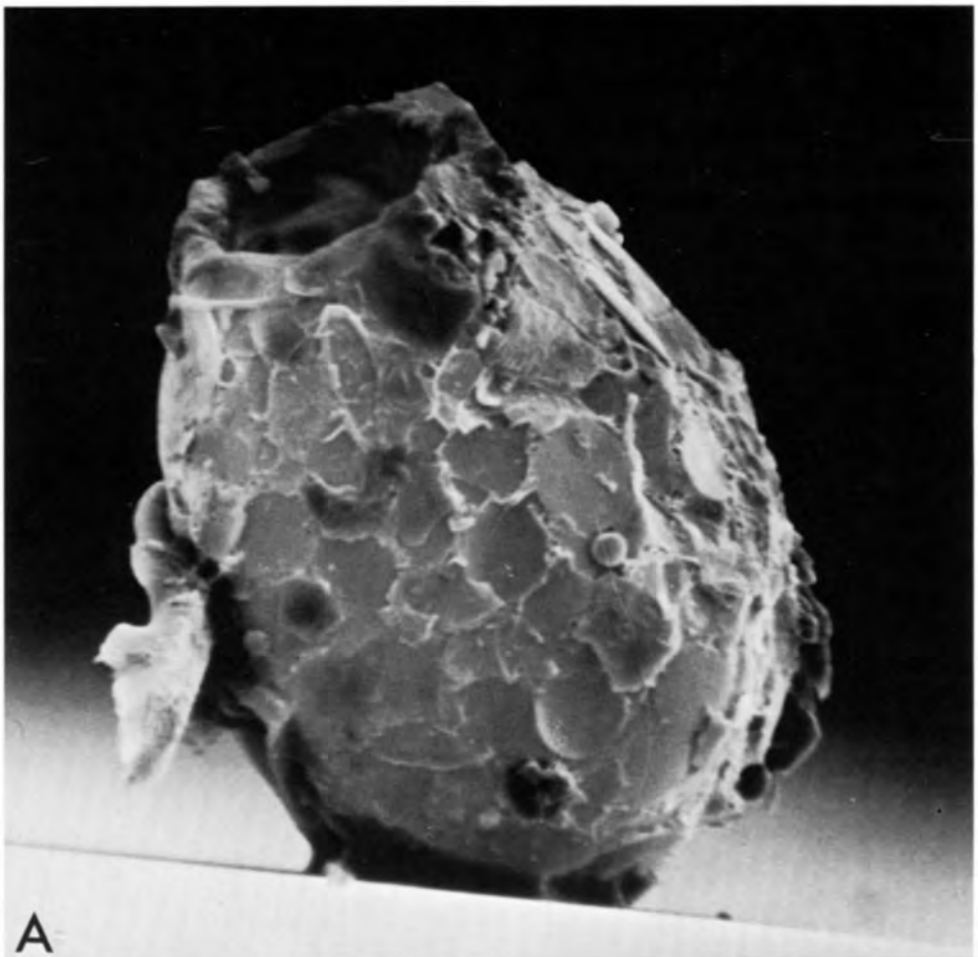
MEASUREMENTS (in μm)

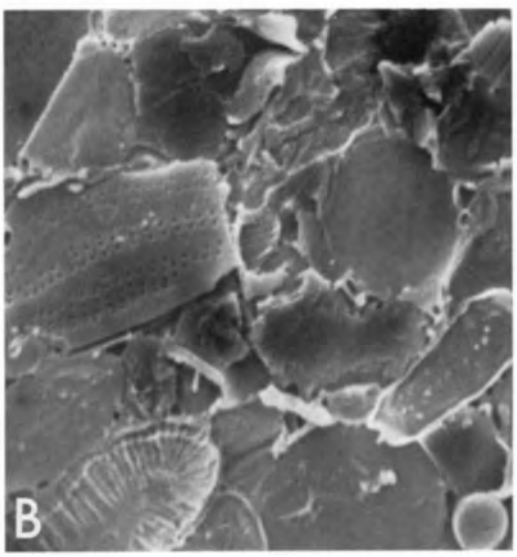
Author	Length of shell	Breadth of shell	Diameter of aperture
Cash *et al.*, 1909	30–40	28	
present work n = 1	37	31	15

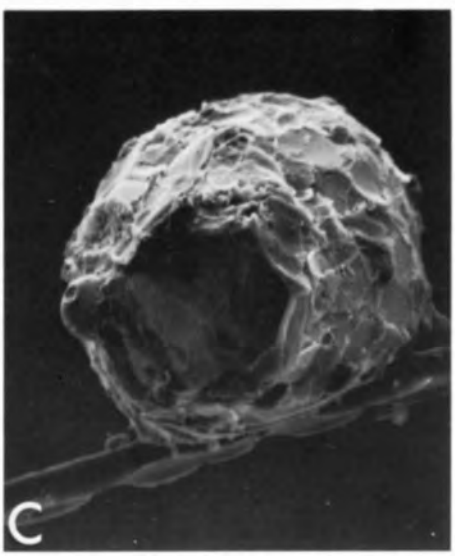
GEOGRAPHICAL DISTRIBUTION Austria, Belgium, British Isles, Bulgaria, France, Germany, Poland, Russia, Switzerland.

REFERENCES Chardez, 1961*a*; Golemansky, 1970, 1974*b*; Laminger, 1975.

Fig. A Lateral view × 2600
Fig. B Portion of shell × 5000
Fig. C Apertural view × 1700


A


B


C

Pseudodifflugia fulva (Archer, 1870)

DESCRIPTION The shell is yellow or light brown, small, ovoid, but circular in transverse section (Figs. A and B). The irregular outline is produced by the covering of extraneous particles (Figs. A, B and D). The aperture is roughly circular (Fig. B) and appears to have a thin border of organic cement (Fig. C).

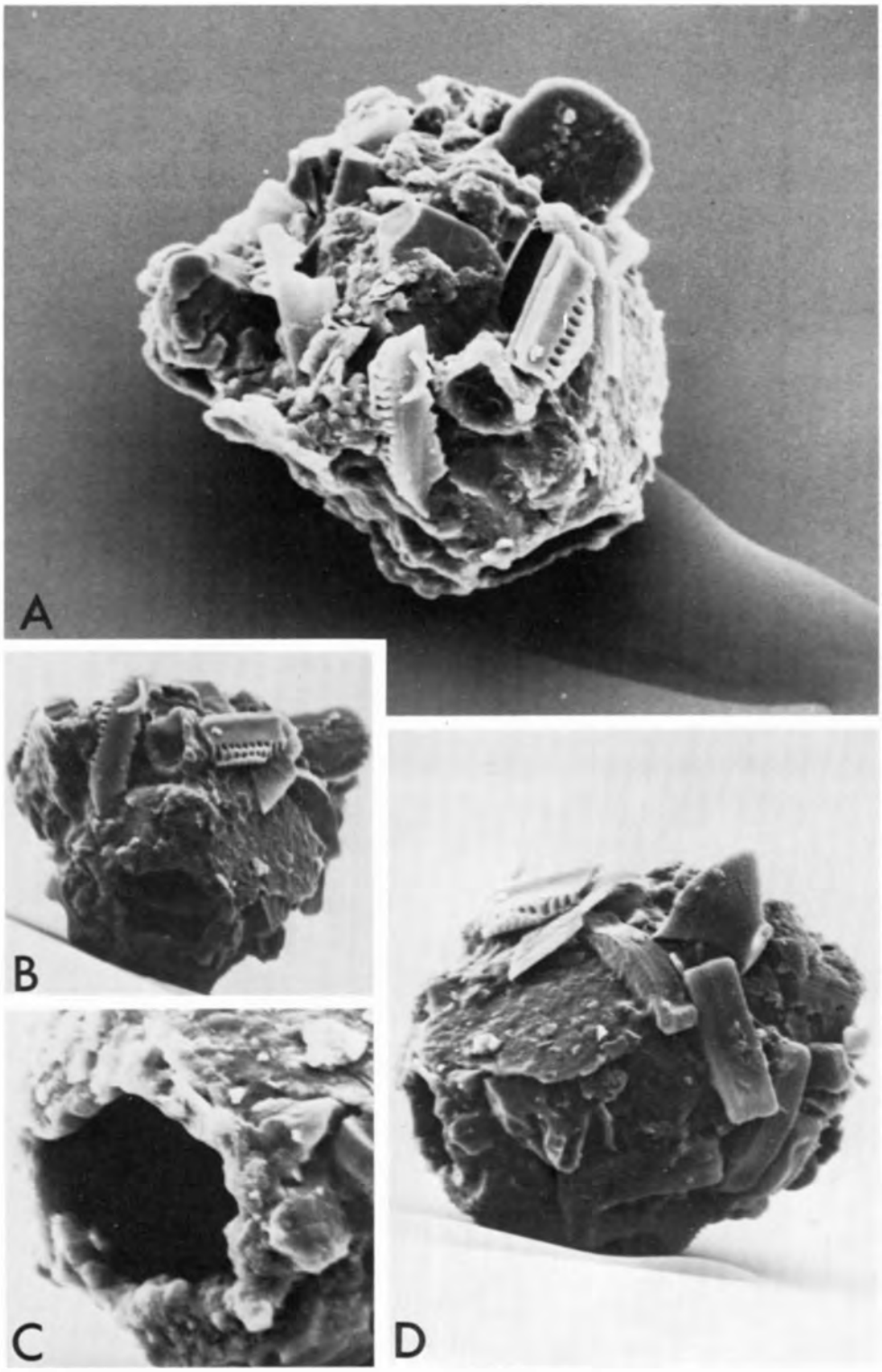
MEASUREMENTS (in μm)

Author	Length of shell	Breadth of shell	Diameter of aperture
Cash *et al.*,	15–30	12–20	6–12
present work n = 1	36	30	12

GEOGRAPHICAL DISTRIBUTION Australia, British Isles, Congo, France, Germany, Switzerland.

REFERENCES Playfair, 1918; Steineke, 1914.

Fig. A Latero-apertural view × 1700
Fig. B Apertural view × 1100
Fig. C View of aperture to show the irregular outline × 3300
Fig. D Lateral view × 1500


A
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Pseudodifflugia gracilis Schlumberger, 1845

DESCRIPTION The shell is yellow or brown, circular in broad view and hemispherical in lateral view (Figs. A and B). It is composed mainly of small sand and grains. The aperture is circular and bordered by an arrangement of small particles embedded in an organic matrix (Figs. A and C).

Variation in shape, size of aperture and composition of the shell were described by Penard (1902).

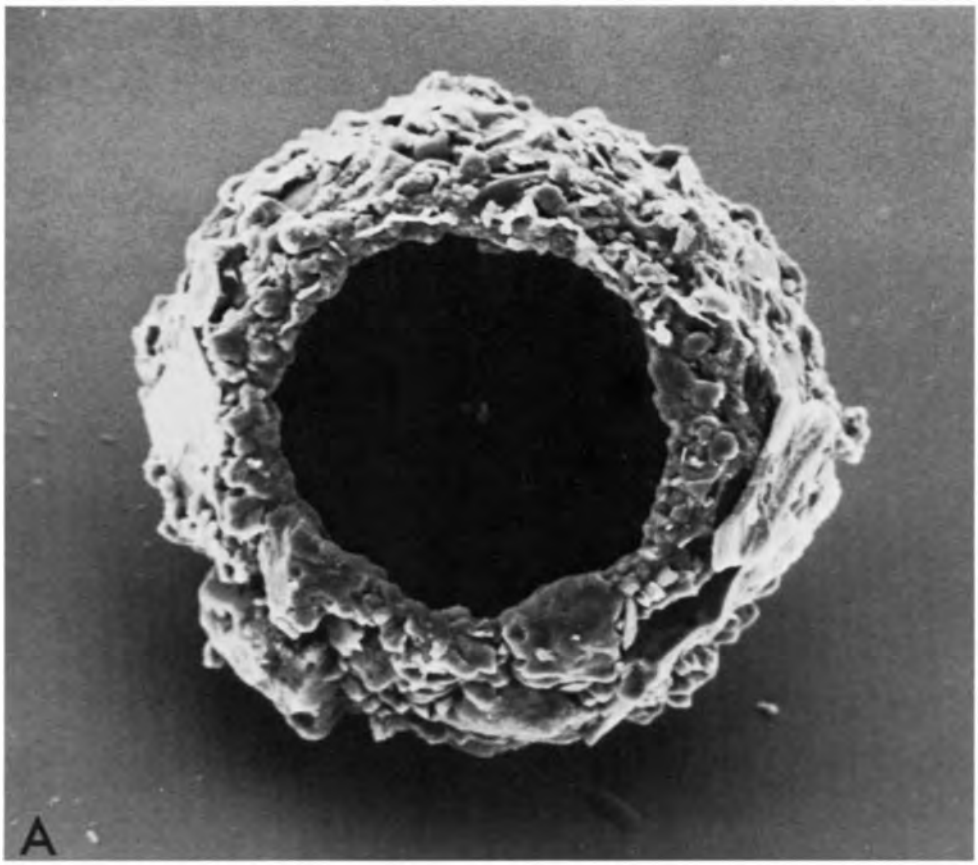
MEASUREMENTS (in μm)

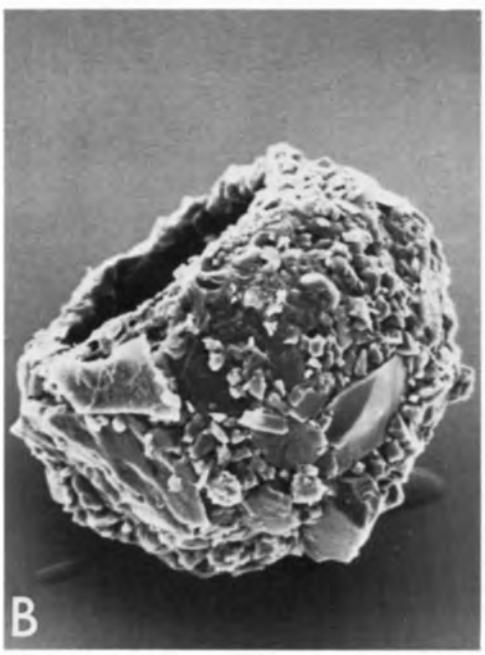
Author	Length of shell	Breadth of shell	Diameter of aperture
Penard, 1902	20–65		
Cash *et al.*, 1915	30–55		10–20
present work n = 2	57–72	37–45	33–42

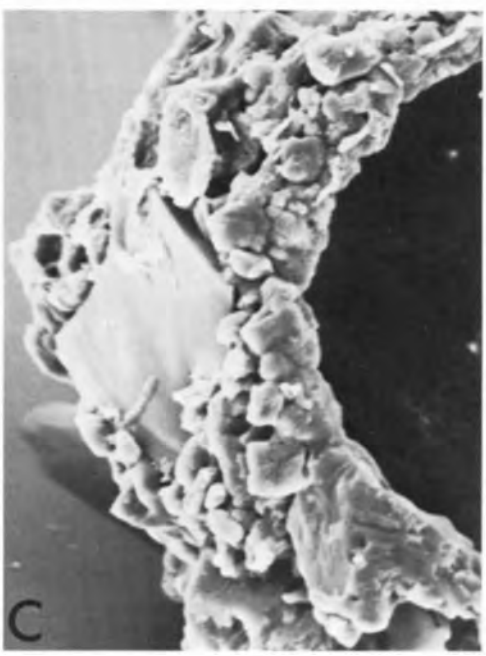
GEOGRAPHICAL DISTRIBUTION Austria, Belgium, British Isles, Bulgaria, Congo, Elephant I., France, Germany, Netherlands, Russia, Signy I., United States of America.

REFERENCES Chardez, 1961*a*; Golemansky, 1974*b*; Laminger, 1972*a*, 1975; Playfair, 1918; Smith, 1972, 1973*a*; Steineke, 1914; Štěpánek, 1963.

Fig. A Apertural view × 1500
Fig. B Lateral view × 1000
Fig. C Portion of shell surrounding the aperture × 2200


A


B


C

Euglypha acanthophora (Ehrenberg, 1841)

DESCRIPTION The shell is ovoid, circular in transverse section and composed of about two hundred, oval, shell-plates and up to six elongated shell-plates (Fig. A). The elongated shell-plates are about twice as long as the usual shell-plate (Fig. D) and normally project from the aboral region of the shell, but often they follow the curvature of the shell and are not easily seen. The aperture is circular and surrounded by ten to thirteen evenly spaced apertural-plates (Fig. B). Each apertural-plate is roughly circular and carries a large median tooth with either four or five smaller lateral teeth on each side (Fig. C). Apertural-plates not only border the aperture, but are also seen in the second and third row of plates inside the aperture.

In clonal cultures abnormally shaped shells occur which are either specimens with deformed apertural regions, or small specimens about half or two-thirds normal length, with wide apertures (Hedley *et al.*, 1974).

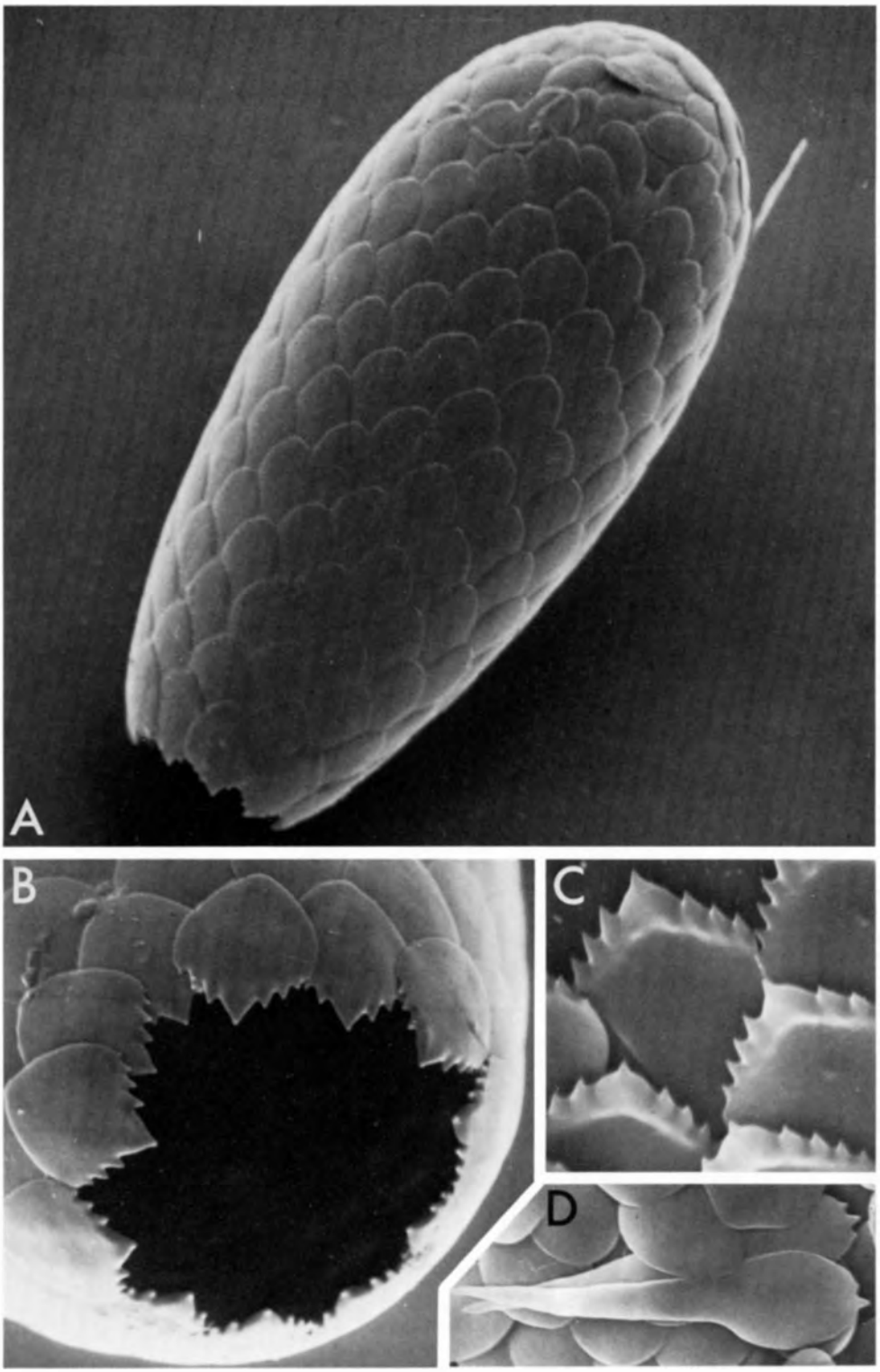
MEASUREMENTS (in μm)

Author	Shell		Diameter of aperture	Shell-plates		Apertural plates		Length of elongated shell-plates
	length	width		length	width	length	width	
Cash *et al.*, 1915	55–80	28–40	14–20					20–35
Hedley *et al.*, 1974 n = 100	53–84	29–46	18–25	10.9–12	7.9–9.1	8.1–12.5	7.2–11.4	17–26

GEOGRAPHICAL DISTRIBUTION Australia, Belgium, Brazil, British Isles, Bulgaria, Canada, China, Colombia, Congo, Costa Rica, Czechoslovakia, France, Germany, Greenland, Hungary, Iceland, Japan, Java, Luxembourg, Madagascar, Netherlands, New Zealand, Poland, Roumania, Russia, South Africa, Spain, Sumatra, Sweden, Switzerland, United States of America, Venezuela, West Africa.

REFERENCES Decloitre, 1947, 1949, 1962, 1965; Godenau *et al.*, 1973; Golemansky, 1970, 1973, 1974*b*; Green, 1975; Hedley *et al.*, 1974; Laminger, 1972*a*, 1973*b*; Schönborn, 1975; Štěpánek, 1963.

Fig. A Lateral view × 1900
Fig. B View of aperture × 2900
Fig. C Apertural plate preparation × 3500
Fig. D Preparation of shell plates to illustrate two elongated shell plates × 2500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Euglypha compressa Carter, 1864

DESCRIPTION The shell is ovoid, laterally compressed, and composed of approximately two hundred, oval, shell-plates and up to forty thickened siliceous spines (Fig. A). Spines project from close to the lateral margins at an angle of 90° to the shell surface (Figs. B and E). Individual spines appear to be semi-circular at their bases but taper distally to a point (Fig. D). Although these spines may vary in length, they are always stout compared with the thin spines of *E. strigosa*. The aperture is oval and surrounded by either eleven or twelve apertural-plates (Fig. C). Each apertural plate is oval, thickened at the denticulate margin and carries a large median tooth and three smaller lateral teeth.

Variation appears to be restricted to the number and size of the siliceous spines.

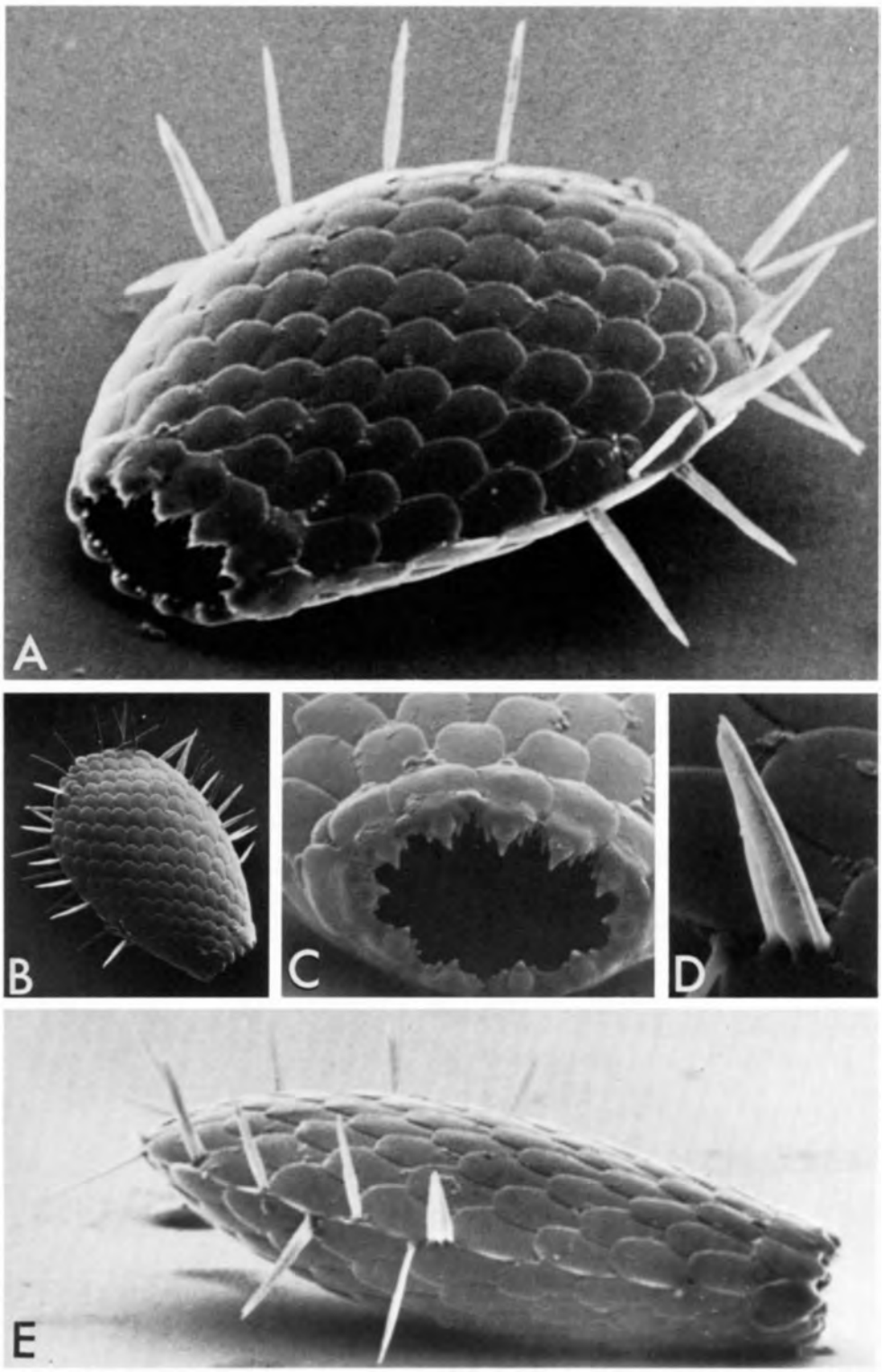
MEASUREMENTS (in μm)

Author	Shell		Diameter of aperture	Shell-plates		Apertural plates		Length of spines
	length	width		length	width	length	width	
Cash *et al.*, 1915	70–132	40–80	18–28	9–12				5–35
present work n=6	74–112	38–69	16–25	11–14	4.5–7.6	8.5–10	5.5–7.0	12–23

GEOGRAPHICAL DISTRIBUTION Antarctica, Auckland I., Australia, Austria, Belgium, British Isles, Canada, Canary I., Chile, Columbia, Costa Rica, Czechoslovakia, France, Germany, Greece, Greenland, Guatemala, Hawaii, Iceland, Italy, Macquaire I., Marion I., Netherlands, New Zealand, Roumania, Russia, Spain, Stewart I., Spitzbergen, Sumatra, Sweden, Switzerland, United States of America.

REFERENCES Bonnet, 1966, 1967*b*; Decloitre, 1962, 1965; Godenau *et al.*, 1973; Gracia, 1965*b*; Grospietch, 1971; Laminger, 1972*a*, 1973*b*; Lousier, 1976.

Fig. A View to show the position of spines along the lateral margin × 1000
Fig. B Broad lateral view × 270
Fig. C View of aperture × 1400
Fig. D Single siliceous spine × 3300
Fig. E Narrow lateral view × 900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Euglypha cristata Leidy, 1874

DESCRIPTION The shell is ovoid, circular in transverse section and is composed of about eighty, oval, shell-plates (Fig. A). The shell-plates are arranged in a regular pattern except for an opening in the centre of the aboral region, from which as many as eleven, long, thin, tapering, siliceous spines project (Fig. B). These long spines curve and intertwine, which suggests that they are not as rigid as the shorter spines of either *E. compressa* or *E. strigosa*. The aperture is circular and surrounded by either five, six, or seven denticulate apertural plates (Fig. C). Each apertural-plate is roughly circular and carries a large median tooth with either three or four smaller lateral teeth (Fig. D). The denticular margin of these plates is thickened.

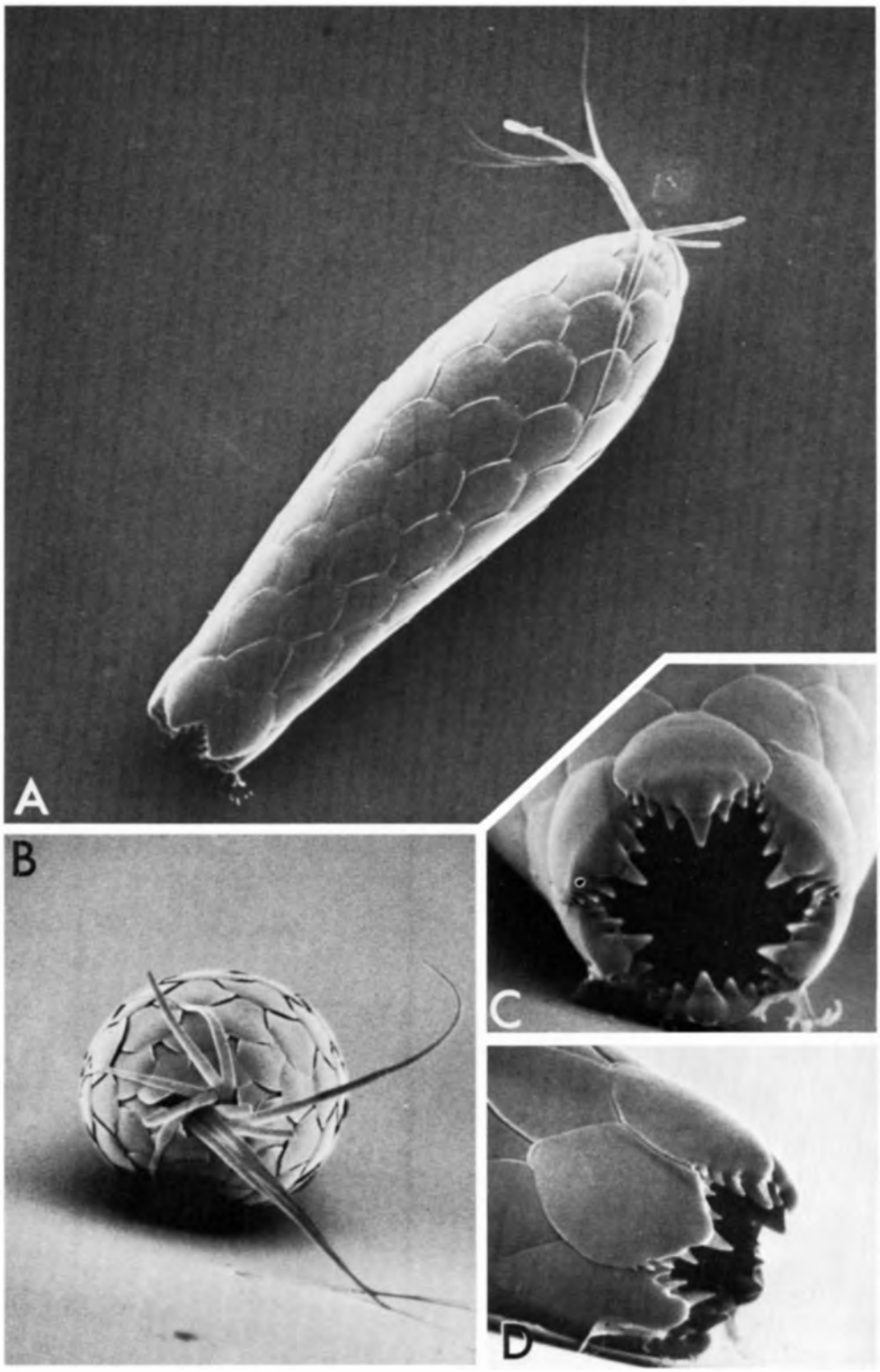
MEASUREMENTS (in μm)

Author	Shell		Diameter of aperture	Shell-plates		Apertural-plates		Length of spines
	length	width		length	width	length	width	
Cash *et al.*, 1915	33–70	12–23	6–12	4.5–9.5	2.5–6.5			10–15
present work n = 3	55–69	14–22	7.0–9.7	9.4–9.8	6.2–7.5	7.8–9.2	5.9–6.4	20–31

GEOGRAPHICAL DISTRIBUTION Antarctica, Australia, Austria, Belgium, Brazil, British Isles, Bulgaria, Canada, Chile, Colombia, Congo, Costa Rica, Czechoslovakia, France, Germany, Hungary, Italy, Java, Madagascar, Netherlands, Russia, Spain, Spitzbergen, Sunda I., Switzerland, Venezuela, West Africa.

REFERENCES Bonnet, 1966; Decloitre, 1962; Gracia, 1972; Hoogenraad & Groot, 1940*a*, 1940*b*; Laminger, 1972*a*, 1973*b*, 1975; Štěpaněk, 1963.

Fig. A Lateral view × 1300
Fig. B Aboral view × 1600
Fig. C Aperture × 3250
Fig. D Lateral view of aperture × 3000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Euglypha filifera Penard, 1890

DESCRIPTION The shell is ovoid, slightly compressed, and composed of about one hundred and fifty, oval, shell-plates (Fig. A). Siliceous spines project from the lateral margins, usually in the aboral half of the shell (Fig. C). These spines are long, thin and may be single or in groups of two or three (Figs. A and D). The aperture is circular and surrounded by eight to eleven apertural-plates (Fig. B). Each apertural-plate is oval, thickened at the denticulate margin, has a large median tooth and two smaller lateral teeth on each side.

Variation appears to be restricted to the disposition of the spines.

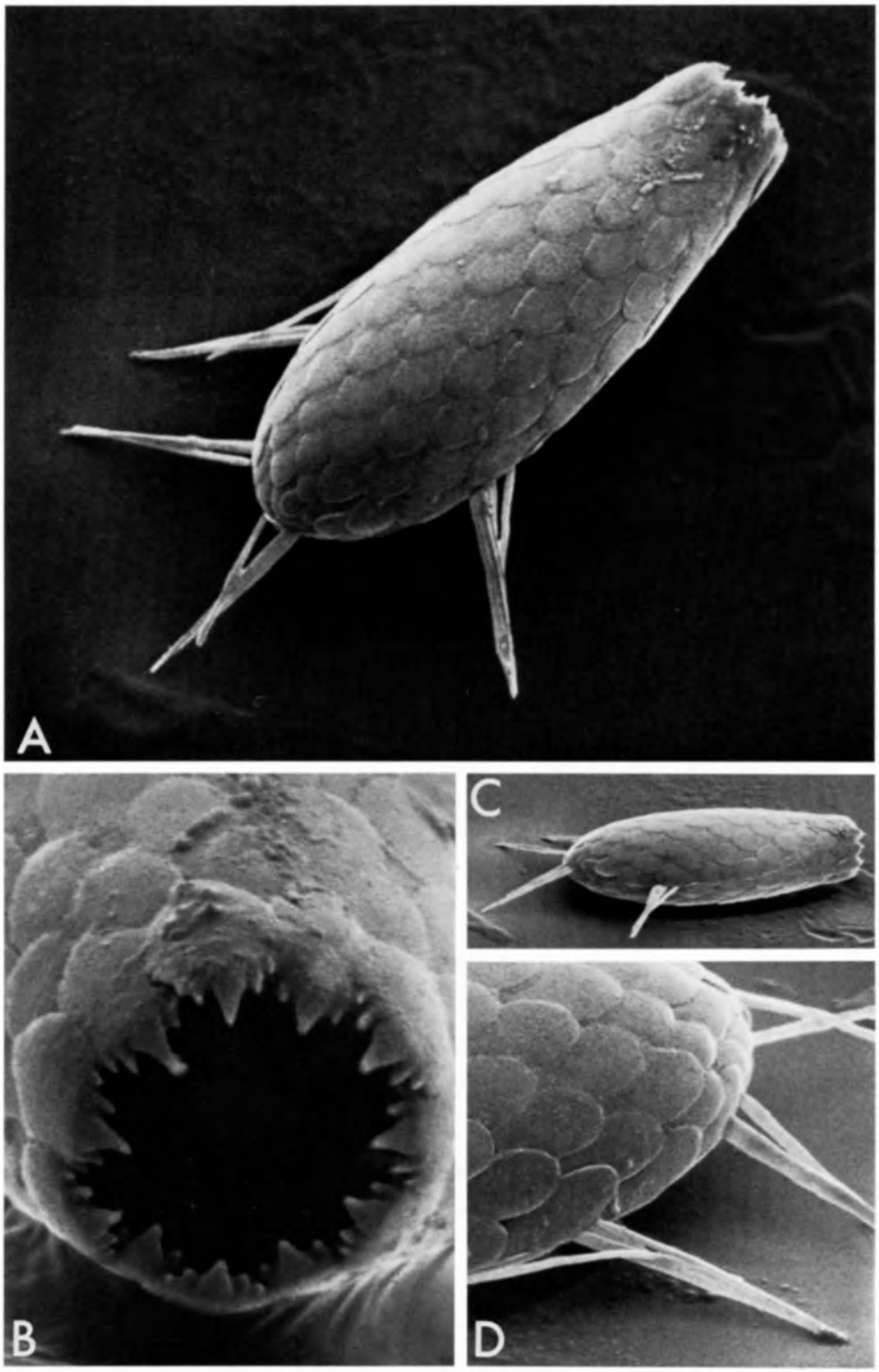
MEASUREMENTS (in μm)

Author	Shell		Diameter of aperture	Shell-plates		Apertural-plates		Length of spines
	length	width		length	width	length	width	
Cash *et al.*, 1915	55–70	25–35	10–14	9–10	4·5–5			13–23
present work n = 2	53–66	26–30	11–11·5	8.6–10.8	4·5–5·4	8.0–9.3	4·9–5·4	14–18

GEOGRAPHICAL DISTRIBUTION Australia, Belgium, Brazil, British Isles, Bulgaria, Canada, Chile, Colombia, Congo, Costa Rica, Czechoslovakia, France, Germany, Hungary, Iceland, Italy, Japan, Netherlands, Poland, Roumania, Russia, South Africa, Spain, Sunda I., Sweden, Switzerland, United States of America, West Africa.

REFERENCES Bonnet, 1966; Decloitre, 1949, 1962, 1965; Godenau *et al.*, 1973; Golemansky, 1974*b*; Green, 1975; Grospietch, 1958*b*; Laminger, 1972*a*, 1973*b*; Štěpánek, 1963.

Fig. A Lateral view × 1300
Fig. B View of aperture × 3700
Fig. C View of lateral margin × 600
Fig. D View of aboral region showing position of siliceous spines × 2150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Euglypha mucronata Leidy, 1878

DESCRIPTION The shell is ovoid, circular in transverse section, and composed of about one hundred, oval, shell-plates (Fig. A). Projecting from the centre of the aboral region are either one or two elongated shell-plates (Figs. B and C). These elongated shell-plates are about three times the length of a normal shell-plate, of which two thirds is tapered to a fine point. The aperture is circular and surrounded by six to eight, oval, apertural-plates (Fig. D). Each apertural-plate is thickened at the denticular margin and carries a large median tooth with three lateral teeth on each side.

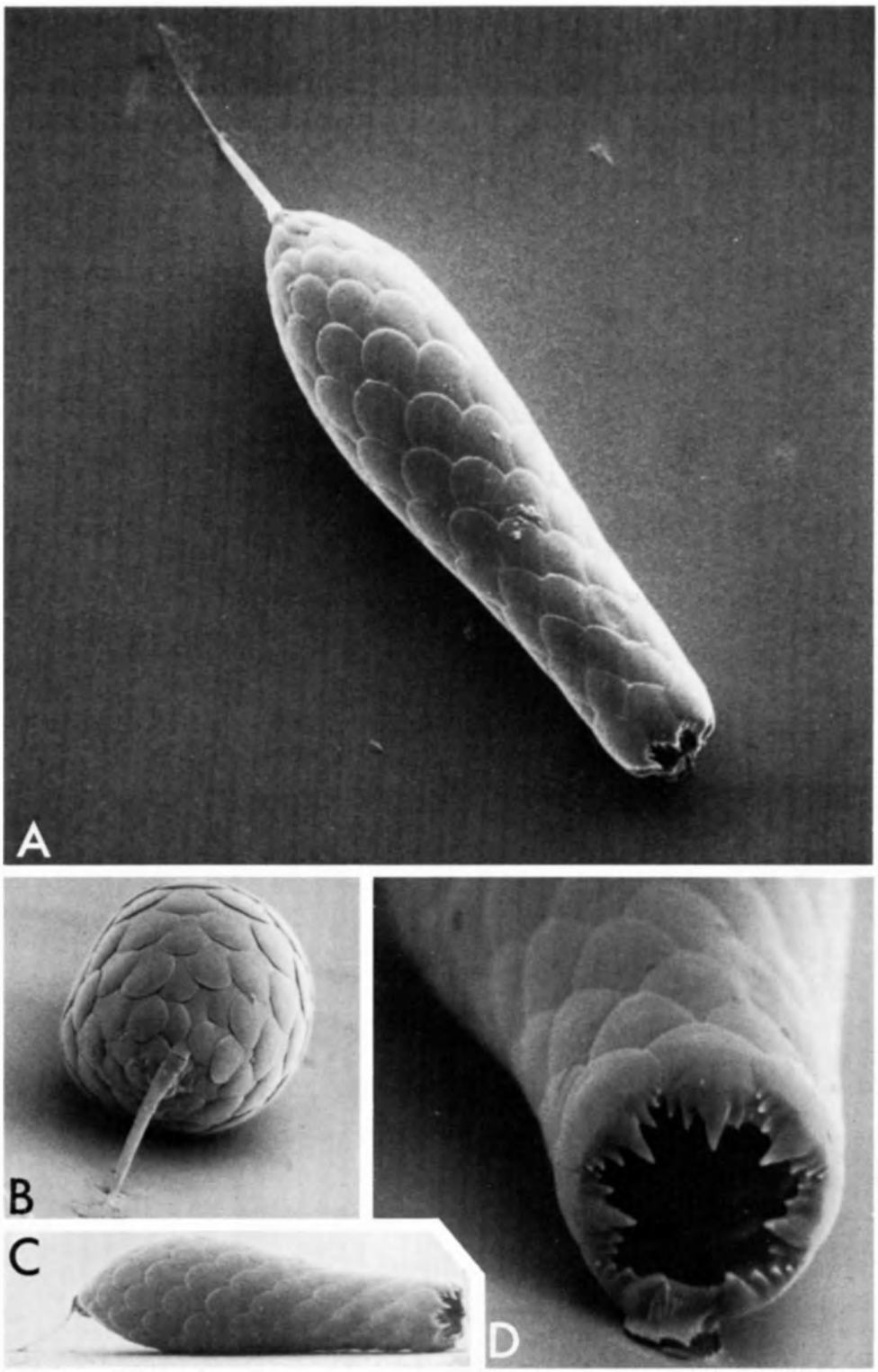
MEASUREMENTS (in μm)

Author	Shell		Diameter of aperture	Shell-plates		Apertural-plates		Length of spines
	length	width		length	width	length	width	
Cash *et al.*, 1915	100–140	32–60	15–20					12–44
present work n = 1	86	23.5	9.5	9.3–10.8	6.2–7.6	10.4–10.8	6.2–7.0	30

GEOGRAPHICAL DISTRIBUTION Algeria, Argentina, British Isles, Canada, Cape Horn, Germany, Italy, Paraguay, Russia, United States of America.

REFERENCES Decloitre, 1962; Vucetich, 1972.

Fig. A Latero-apertural view × 1100
Fig. B Aboral view × 1450
Fig. C Lateral view × 700
Fig. D View of aperture × 2800


A
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Euglypha rotunda Wailes, 1911

DESCRIPTION The shell is ovoid (Fig. A), and varies in transverse section from circular to oval as it tapers from the mid-body region to the aboral region (Fig. B). It is composed of approximately one hundred and twenty, oval, shell-plates. The aperture is circular and surrounded by eight to fourteen evenly spaced apertural-plates (Fig. C). Each apertural-plate is ovoid, thickened at the denticulate margin and carries a large median tooth which is bordered by two or three smaller teeth (Fig. D).

In both cultured and wild animals variation appears to be restricted to the occasional large individual, usually having double the normal complement of shell and apertural-plates (Hedley & Ogden, 1973).

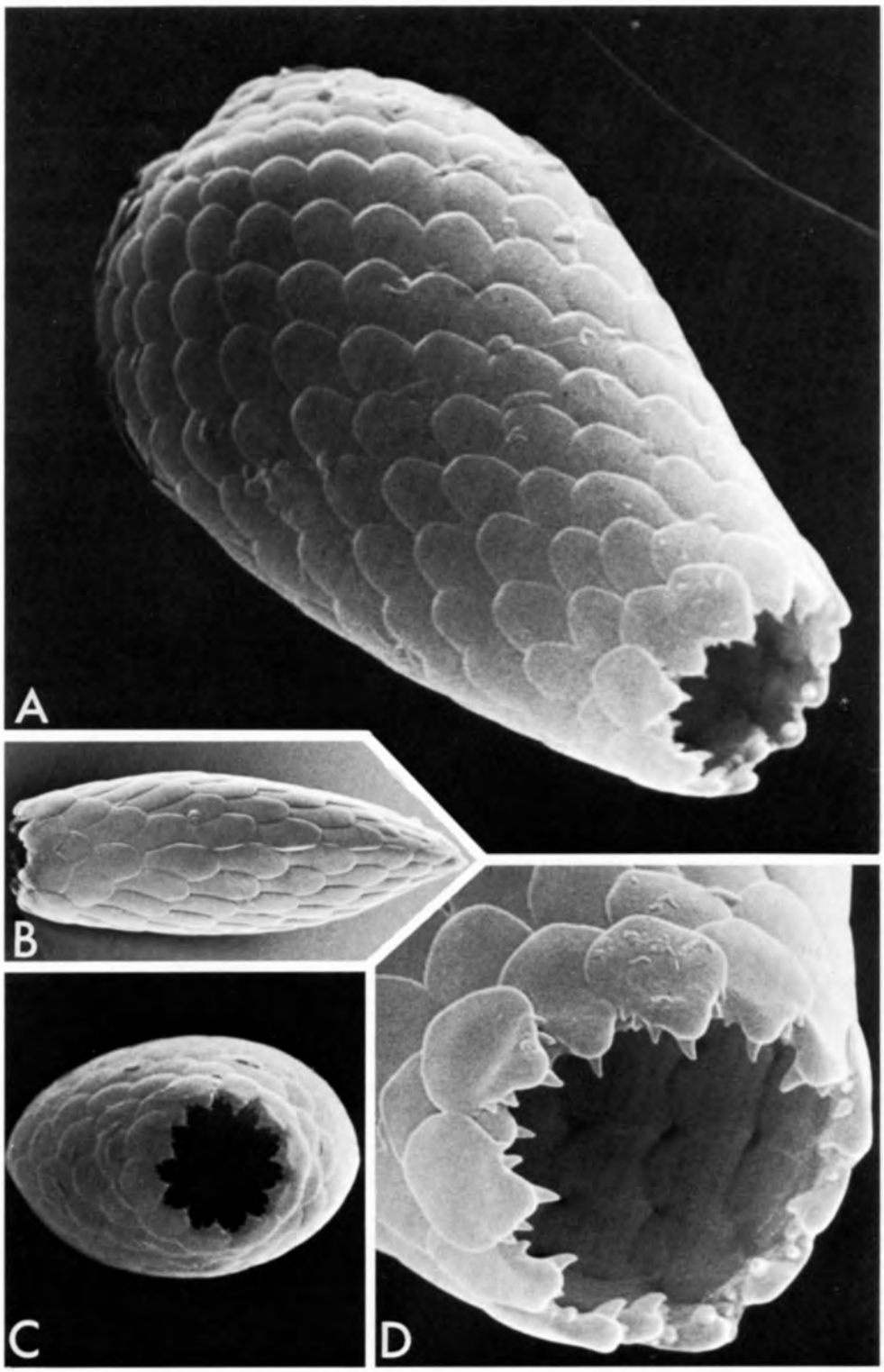
MEASUREMENTS

Author	Shell		Diameter of aperture	Shell-plates		Apertural-plates	
	length	width		length	width	length	width
Cash *et al.*, 1915	22–52	11–36	6–12	5–8	2.5–4		
Hedley and Ogden, 1973 n = 100	34–54	14–24	6–10	5.0–7.3	2.9–4.5	4.5–5.5	3.6–4.5

GEOGRAPHICAL DISTRIBUTION Angola, Annobón I., Antarctica, Austria, Belgium, British Isles, Canada, Ceylon, Chile, Colombia, Costa Rica, Elephant I., France, Germany, Greenland, Guatemala, Hungary, Iceland, India, Java, Macquaire I., Madagascar, Marion I., Mexico, Morocco, Netherlands, New Zealand, Peru, Poland, Roumania, Russia, South Georgia, Spain, Spitzbergen, Sumatra, Sweden, Switzerland, Tahiti, Tasmania, Turkistan, United States of America, Venezuela, West Africa.

REFERENCES Bonnet, 1960, 1966, 1967*a*; Chardez, 1972; Decloitre, 1949, 1961*b*, 1962, 1965, 1966; Godenau *et al.*, 1973; Golemansky, 1970, 1973; Gracia, 1963; Grospietch, 1971; Hedley & Ogden, 1973; Laminger, 1973*b*, 1975; Lousier, 1976; Nair & Mukherjee, 1966; Schönborn, 1975; Smith, 1972; Štěpánek, 1963.

Fig. A Latero-apertural view to show the arrangement of shell plates × 2800
Fig. B Lateral view × 1550
Fig. C Apertural view × 1200
Fig. D Aperture with fourteen apertural plates × 4800


A
B
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D

Euglypha strigosa (Ehrenberg, 1872)

DESCRIPTION The shell is ovoid, laterally compressed, and is composed of about three hundred, oval, shell-plates (Figs. A and B). Siliceous spines may project from the junctions of the shell-plates either singly or in pairs. They are randomly distributed over the whole of the body surface and vary in both size and shape. The spines are held in position by organic cement and are often dislodged in preparation. The aperture is oval and surrounded by ten to thirteen denticulate apertural-plates (Fig. C). Each apertural-plate is roughly oval, thickened at the denticulate margin, and carries a large median tooth with either three or four smaller teeth on each side (Figs. C and D).

In clonal cultures abnormal forms with a curved neck have been seen. In wild populations differences in shell size and shape were suggested by Chardez and Leclercq (1963) to be related to the type of habitat.

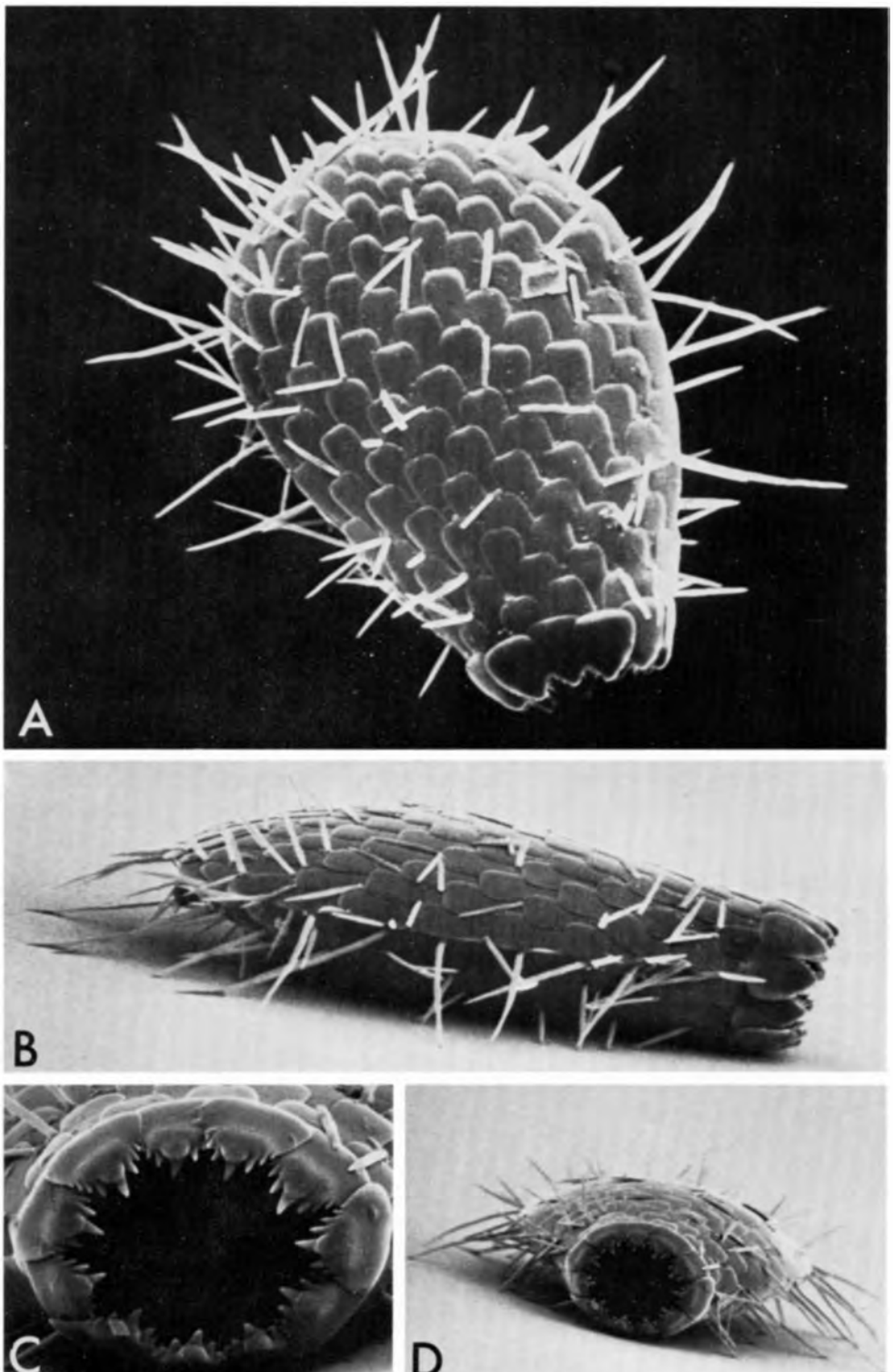
MEASUREMENTS (in μm)

Author	Shell		Diameter of aperture	Shell-plates		Apertural-plates		Length of spines
	length	width		length	width	length	width	
Cash *et al.*, 1915	45–100	30–60	12–23	7–10.5	4.5–5.5			5–15
Hedley et al., 1974 n = 100	73–89	32–52	14–17	8.0–11.3	4.1–6.4	9.2–10.8	7.8–8.5	2–23

GEOGRAPHICAL DISTRIBUTION Adelaide I., Antarctica, Australia, Balearic I., Belgium, Borneo, British Isles, Bulgaria, Canada, Canary I., Chile, Colombia, Costa Rica, Czechoslovakia, Finland, France, Germany, Greece, Greenland, Hungary, Iceland, Italy, Java, Krakatoa I., Madagascar, Netherlands, New Zealand, Norway, Poland, Roumania, Russia, South Africa, Spain, Spitzbergen, Sunda I., Sweden, Switzerland, Tasmania, Venezuela, United States of America, West Africa.

REFERENCES Bonnet, 1966, 1967*b*; Decloitre, 1962, 1965; Golemansky, 1970, 1973, 1974*b*; Gracia, 1965*a*; Grospietch, 1971; Hedley *et al.*, 1974; Laminger, 1973*b*; Lousier, 1976; Štěpánek, 1963.

Fig. A Broad lateral view × 1000
Fig. B Narrow lateral view × 1000
Fig. C Aperture with denticulate apertural plates × 1700
Fig. D Apertural view × 700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Euglypha tuberculata Dujardin, 1841

DESCRIPTION The shell is ovoid, circular in transverse section and is composed of approximately one hundred, oval, shell-plates (Figs. A and B). The aperture is circular and surrounded by eight to twelve, oval, apertural-plates (Fig. E). The apertural-plates are barely thickened at the denticulate margin (Fig. D), and have a small triangular median tooth with either four or five, smaller, lateral teeth (Figs. C and E).

Slight differences in shape have been reported by Decloitre (1965).

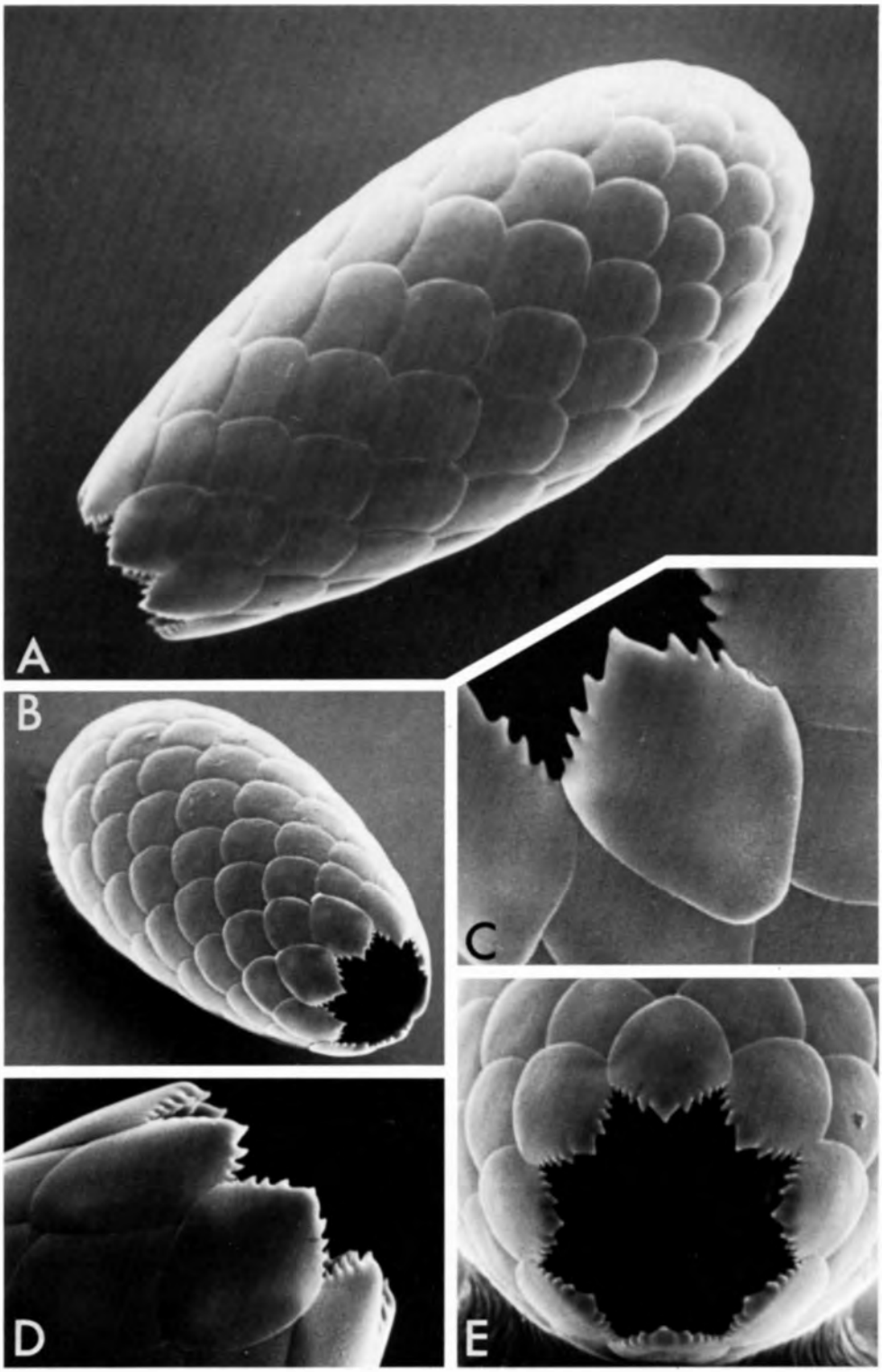
MEASUREMENTS (in μm)

Author	Shell		Diameter of aperture	Shell-plates		Apertural-plates	
	length	width		length	width	length	width
Cash *et al.*, 1915	45–100	24–50	10–20	10–16			
present work n = 9	74–95	36–51	18–21	13.2–14.7	8.7–10.8	10.8–15.1	8.0–10.2

GEOGRAPHICAL DISTRIBUTION Algeria, Antarctica, Argentina, Australia, Austria, Azores, Belgium, Brazil, British Isles, Bulgaria, Canada, Chile, China, Colombia, Cuba, Czechoslovakia, Faroes, Finland, France, Germany, Greenland, Haiti, Hungary, Iceland, Italy, Japan, Maquaire I., Madagascar, Mexico, Morocco, Netherlands, New Zealand, Paraguay, Roumania, Russia, Spitzbergen, Sunda I., Sweden, Switzerland, Tahiti, United States of America, Venezuela, West Africa.

REFERENCES Bonnet, 1966; Decloitre, 1947, 1962, 1965, 1966; Golemansky, 1970, 1973, 1974*b*; Green, 1975; Lousier, 1976; Schönborn, 1975.

Fig. A Lateral view × 1250
Fig. B Latero-apertural view × 900
Fig. C A single apertural plate × 3600
Fig. D Lateral view of aperture × 2400
Fig. E Apertural view × 1850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Assulina muscorum Greef, 1888

DESCRIPTION The shell is brown, ovoid, laterally flattened and composed of approximately three hundred shell plates (Figs. A and B). The aperture is oval, surrounded by shell plates and bordered by a band of organic cement (Fig. C). The amount of cement around the aperture varies, but is often pronounced (Fig. D).

Although the shell plates are usually arranged in longitudinal rows they may sometimes appear irregular (Cash *et al.*, 1915).

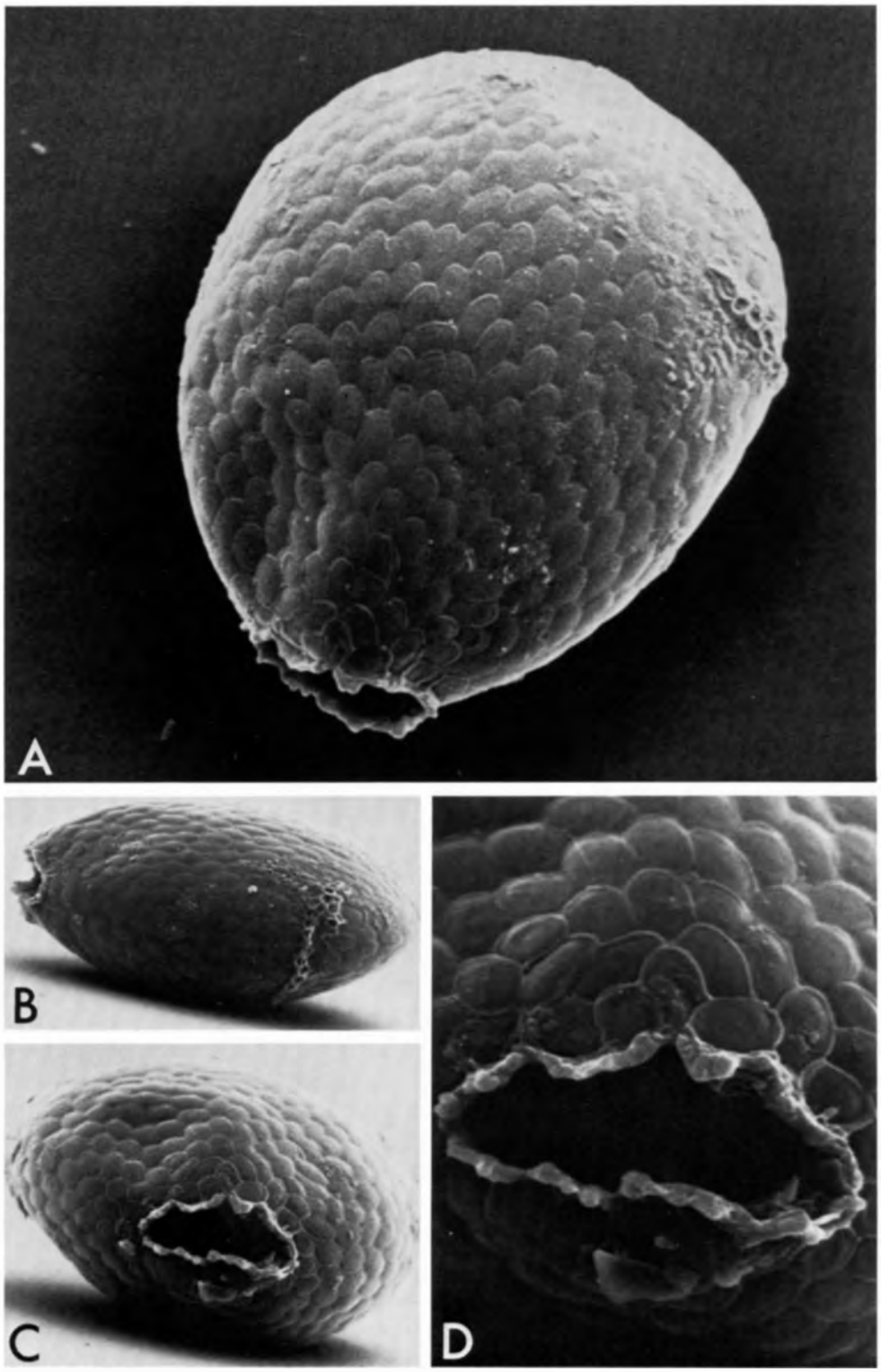
MEASUREMENTS (in μm)

Author	Length of shell	Breadth of shell	Depth of shell	Diameter of aperture
Cash *et al.*, 1915	28–58	19–50		6–16
present work n=8	45–53	32–48	18–22	12–18

GEOGRAPHICAL DISTRIBUTION Austria, Balearic I., Belgium, British Isles, Bulgaria, Canada, Canary I., Chile, Congo, Costa Rica, Czechoslovakia, Elephant I., France, Germany, Greece, Greenland, Guatemala, Hungary, Iceland, India, Java, Marion I., Netherlands, Nepal, New Guinea, Poland, Russia, Signy I., South Georgia, Spain, Spitzbergen, Sumatra, Sweden, Switzerland, United States of America.

REFERENCES Bonnet, 1966, 1967*b*; Bonnet & Thomas, 1960; Chardez, 1961*a*; Decloitre, 1965; Gracia, 1965*a*, 1965*b*, 1968*a*, 1972; Graaf, 1956; Golemansky, 1970, 1973, 1974*b*; Grospietch, 1971; Hoogenraad & Groot, 1940*a*, 1940*b*, 1946; Jung, 1936*a*; Laminger, 1972*a*, 1972*b*, 1973*b*, 1975; Lousier, 1976; Schönborn, 1975; Smith, 1972, 1973*a*; Štěpánek, 1963.

Fig. A Broad lateral view × 2000
Fig. B Narrow lateral view × 1200
Fig. C Apertural view × 1500
Fig. D View of aperture to illustrate the organic cement × 3850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Assulina scandinavica Penard, 1890

DESCRIPTION The shell is colourless or yellow, ovoid and composed of about three hundred and fifty oval, shell plates (Fig. A). It is laterally flattened and the plates overlap at the margins to give distinct lateral lines (Fig. B). The aperture is oval and is surrounded by shell plates which are bordered by a thin band of organic cement (Figs. C and D).

This species can be distinguished from *A. seminulum* by size and the sharp tapering of the shell from the mid-body position to the aperture.

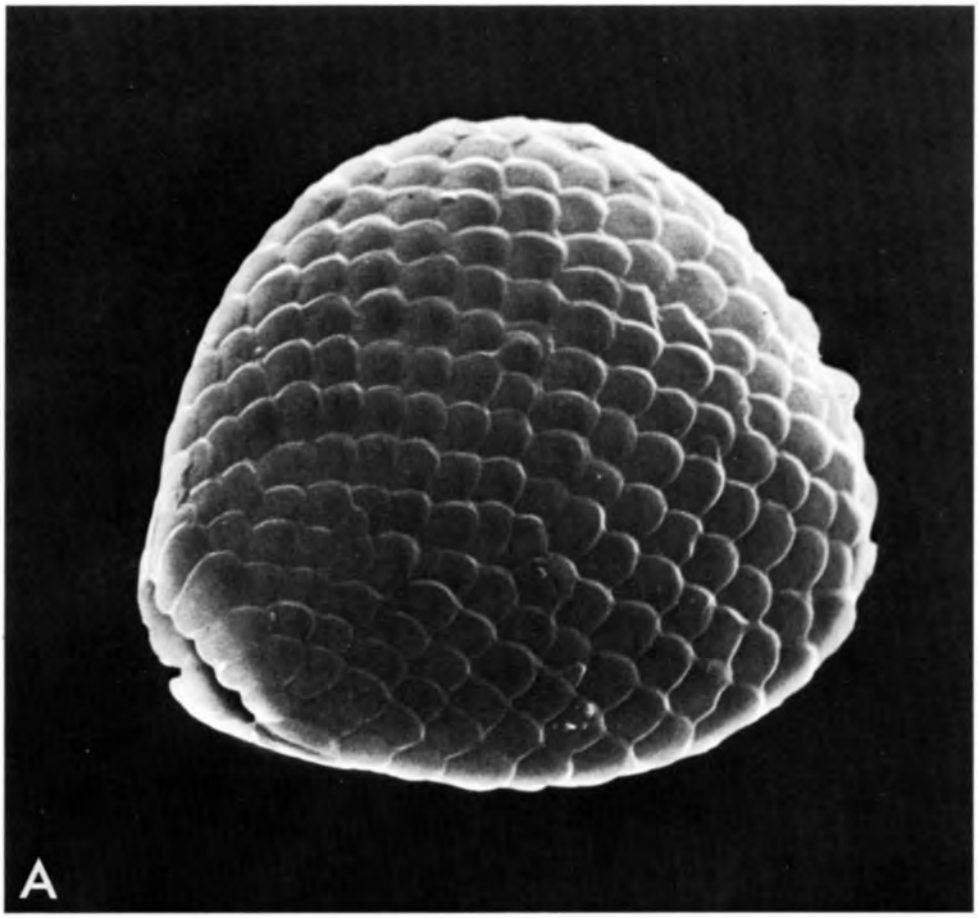
MEASUREMENTS

Author	Length of shell	Breadth of shell	Depth of shell	Diameter of aperture
Cash *et al.*, 1915	80–120	70–110		15–30
present work n = 2	107–114	102–103	39–42	26–30

GEOGRAPHICAL DISTRIBUTION Austria, Belgium, British Isles, Bulgaria, Canada, Colombia, Germany, Greenland, Iceland, Norway, Sweden, Switzerland, United States of America.

REFERENCES Chardez, 1961*a*; Decloitre, 1965; Jung, 1936*a*; Laminger, 1975.

Fig. A Broad lateral view × 700
Fig. B Narrow lateral view × 450
Fig. C Apertural view × 390
Fig. D Part of aperture to show the organic cement border × 1900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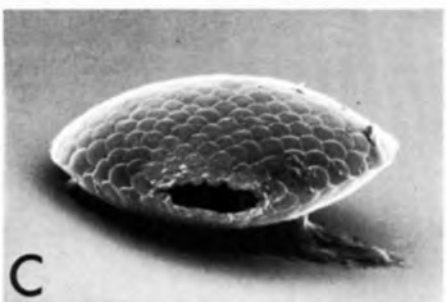
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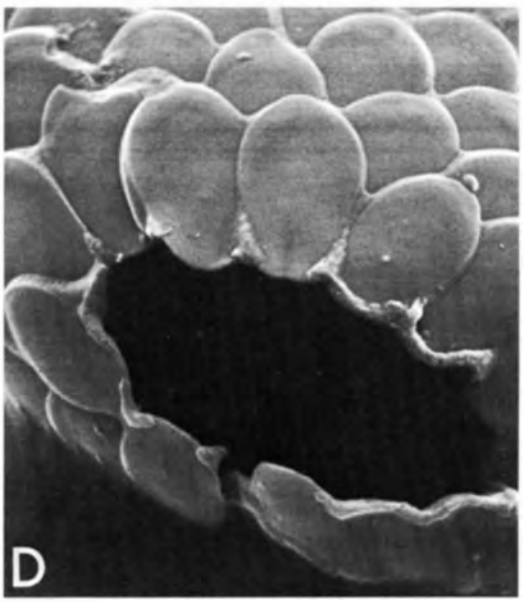

D

Assulina seminulum (Ehrenberg, 1848)

DESCRIPTION The shell is yellowish-brown or colourless, ovoid, and composed of approximately three hundred, oval shell-plates (Fig. A). The shell-plates are arranged regularly but overlap at the margins to give a distinct lateral line (Figs. C and E). The aperture is lenticular and usually surrounded by evenly spaced shell-plates (Figs. B and C), but they may sometimes be arranged haphazardly (Fig. D). On the free margins of these shell-plates is a thin border of organic cement (Fig. B). This border usually surrounds the aperture and appears to be continuous with the cement holding the shell-plates together.

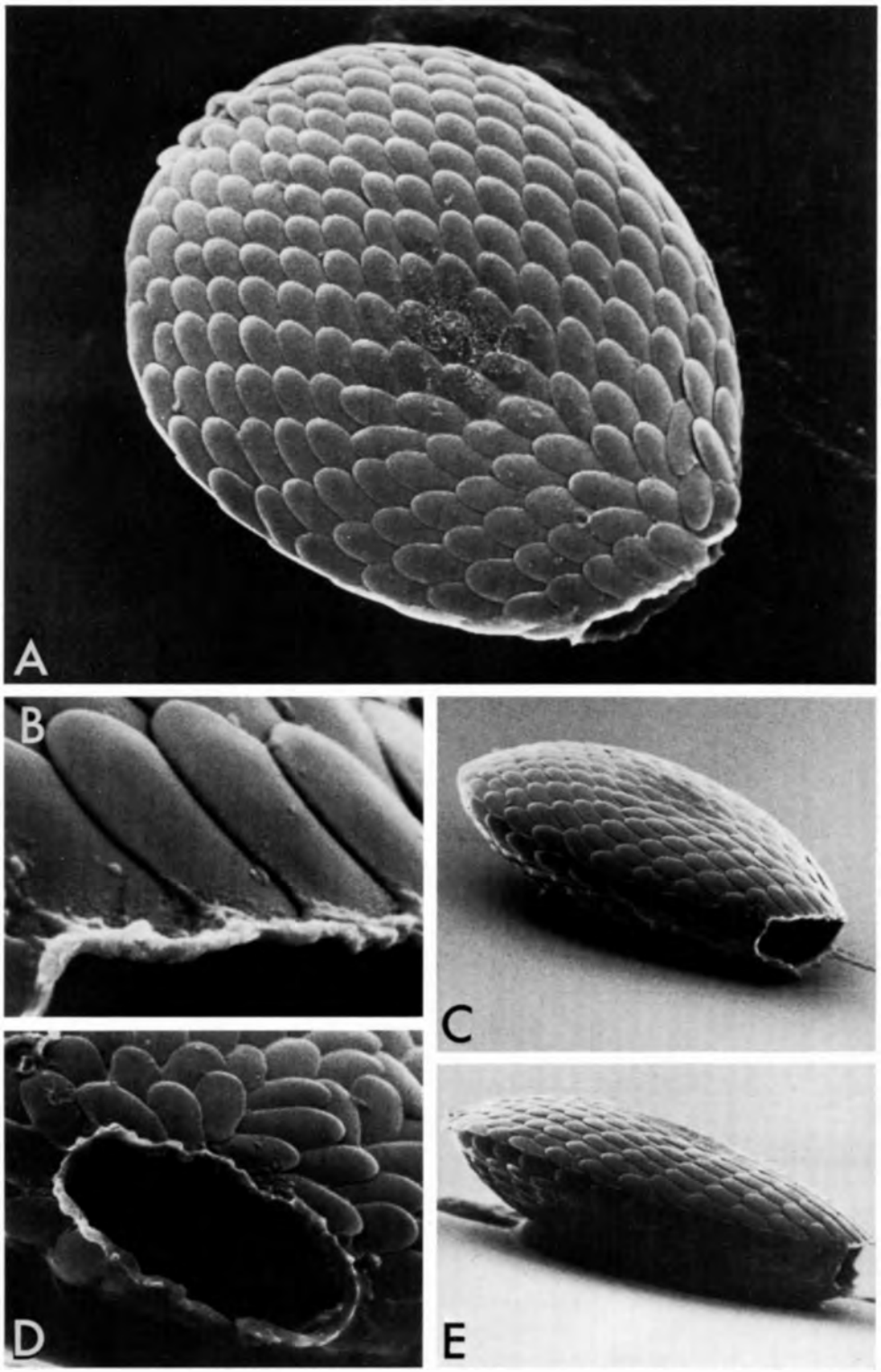
MEASUREMENTS (in μm)

Author	Length of shell	Breadth of shell	Depth of shell	Diameter of aperture
Cash *et al.*, 1915	60–90	50–75		16–15
present work n = 3	72–82	62–74	25–35	21–23

GEOGRAPHICAL DISTRIBUTION Annobón I., Austria, Belgium, British Isles, Canada, Canary I., Chile, Congo, Costa Rica, France, Germany, Greenland, Guatemala, Iceland, Italy, Java, Nepal, Netherlands, New Guinea, Poland, Russia, Spain, Spitsbergen, Sweden, Switzerland, United States of America.

REFERENCES Bonnet, 1966; Chardez, 1961*a*; Decloitre, 1965; Golemansky, 1973; Gracia, 1963, 1965*b*, 1968*a*, 1972; Graaf, 1956; Heal, 1963; Hoogenraad & Groot, 1946; Jung, 1936*a*; Laminger, 1972*a*, 1972*b*, 1973*b*, 1975; Lousier, 1976; Puytorac *et al.*, 1972; Rampi, 1947; Steineke, 1914; Štěpánek, 1963.

Fig. A Broad lateral view × 1000
Fig. B Part of aperture to illustrate the organic cement border × 4800
Fig. C Latero-apertural view × 700
Fig. D Aperture with uneven shell-plates × 1700
Fig. E Narrow lateral view × 700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Placocista spinosa (Carter, 1865)

DESCRIPTION The shell is ovoid and composed of approximately four hundred, oval shell plates (Fig. A). Siliceous spines project from the lateral margins, either singly or in pairs (Figs. A and B). The arrangement of these spines (Fig. E) is such that they are easily broken. The aperture is an elongate slit, whose outline is often irregular due to the arrangement of the shell plates, concave in lateral view and surrounded by a thin collar of organic cement (Figs. C and D).

Different types of spines are figured by Cash (1915), but this appears to be the only variable character.

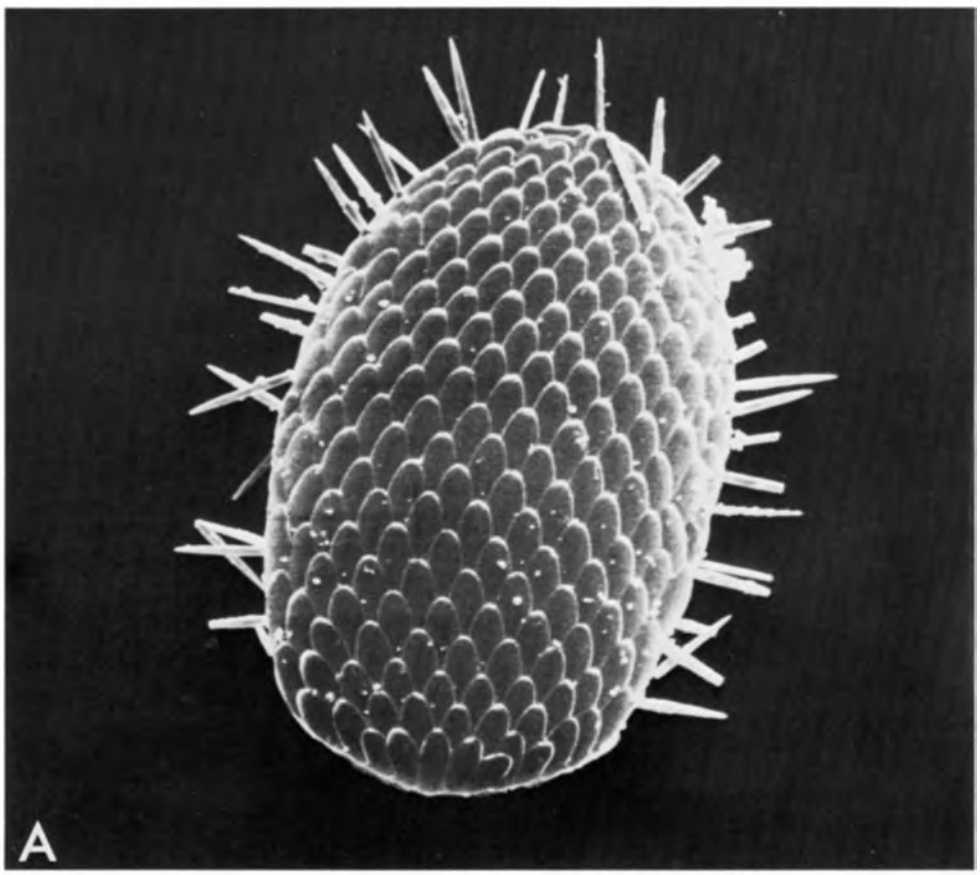
MEASUREMENTS (in μm)

Author	Shell		Diameter of aperture	Shell plates		Length of spines
	length	breadth		length	breadth	
Cash *et al.*, 1915	116–174	71–100	35–70	12–20	7–10	5–35
present work n=6	143–160	87–110	58–79	15–18	7–9	17–29

GEOGRAPHICAL DISTRIBUTION Antarctica, Belgium, British Isles, Canada, France, Germany, Greece, Java, Netherlands, Russia, Sweden, Switzerland, United States of America.

REFERENCES Bonnet, 1967*b*; Chardez, 1961*a*; Heal, 1963*b*; Hoogenraad & Groot, 1946; Jung, 1936*a*; Puytorac *et al.*, 1972; Schönborn, 1975; Steineke, 1914.

Fog. A Broad lateral view × 500
Fig. B Narrow lateral view × 380
Fig. C Lateral view of aperture × 1500
Fig. D View of aperture × 930
Fig. E Apertural view to illustrate the arrangement of spines × 320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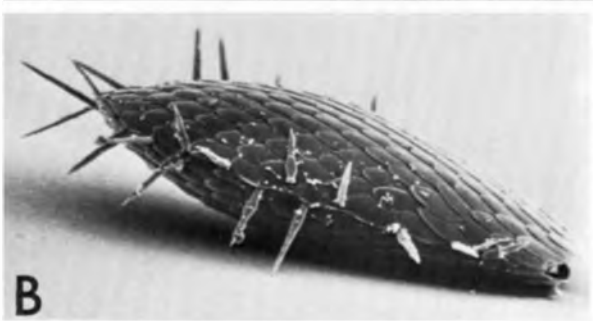
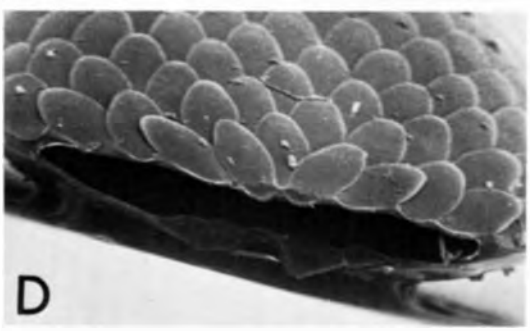

B


C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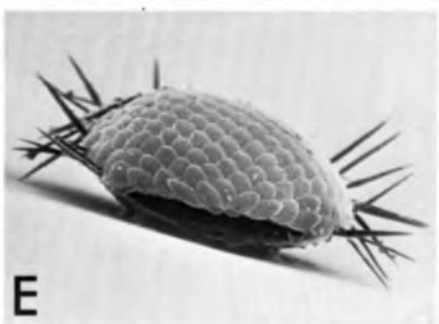

E

Sphenoderia lenta Schlumberger, 1845

DESCRIPTION The shell is usually circular and composed of approximately sixty circular shell-plates (Fig. A). The aperture is terminal, linear and is surrounded by an organic collar. The organic collar is covered with small, oval shell-plates (Figs. B and C), which appear to be randomly arranged and vary from 1.8 to 3 μm in diameter. One lip of the collar is usually concave whilst the other lip is folded inwards (Figs. C and D). This folding makes it difficult to ascertain the correct shape of the apertural opening, but it is assumed that it is long and narrow with semicircular ends.

Differences in the shape and size of the shell-plates and the apertural collar were described by Cash *et al.*, (1915).

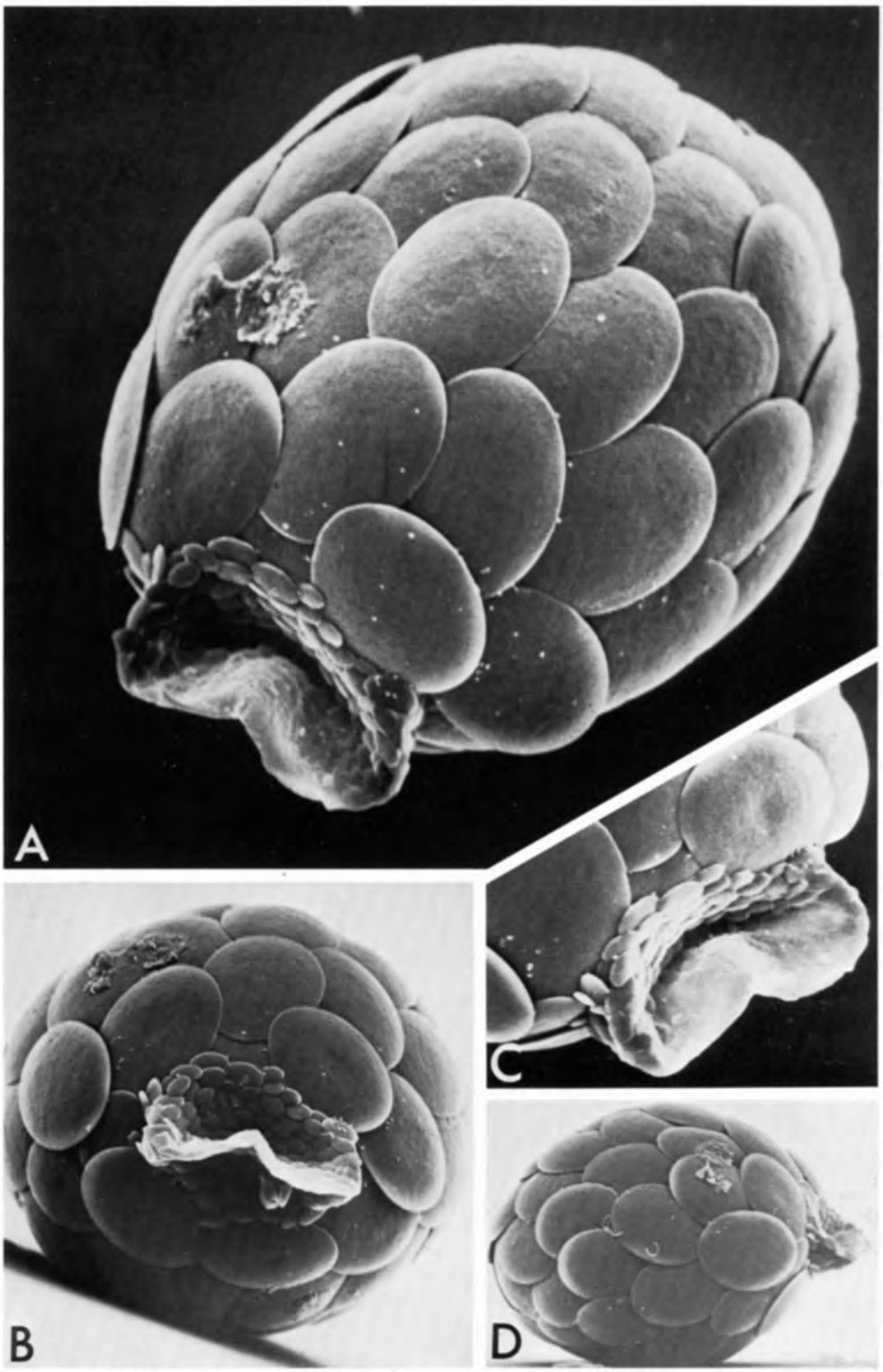
MEASUREMENTS (in μm)

Author	Shell		Diameter of aperture	Shell-plates diameter
	length	width		
Cash *et al.*, 1915	30–60	20–46	10–22	8–13
present work n = 6	47–55	35–40	16–19	10–12.4

GEOGRAPHICAL DISTRIBUTION Austria, Belgium, Brazil, British Isles, Bulgaria, Canada, Congo, Costa Rica, France, Germany, Iceland, Java, Mexico, Netherlands, Poland, Russia, Spain, Sweden, Switzerland, United States of America, Venezuela, West Africa.

REFERENCES Decloitre, 1948, 1949, 1955, 1965; Deflandre, 1926; Golemansky, 1970, 1974*b*; Gracia, 1972; Green, 1975; Hoogenraad & Groot, 1940*a*, 1940*b*, 1946; Jung, 1936*a*; Laminger, 1972*a*, 1972*c*, 1973*b*, 1975; Schönborn, 1975; Štěpánek, 1963.

Fig. A View illustrating the arrangement of the shell-plates × 2400
Fig. B Apertural view × 1680
Fig. C Lateral view of aperture × 2150
Fig. D Lateral view × 1000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Tracheleuglypha dentata (Moniez, 1888)

DESCRIPTION The shell is ovoid, circular in transverse section and composed of approximately one hundred, circular, shell-plates (Figs. A and B). About twelve shell-plates surround the aperture and project only slightly from the following row of overlying shell-plates (Fig. D). The remainder of the shell-plates are arranged in a regular manner. The aperture is circular and is bordered by a collar of organic material, from which tooth-like structures usually project (Figs. C and D). The organic collar is not completely preserved in some specimens, and in these cases the tooth-like projections are absent (Fig. B).

Cash *et al.* (1915) observed that the collar was often difficult to see, and that it was sometimes absent. They also figured variations in the shell-plates from circular to oval.

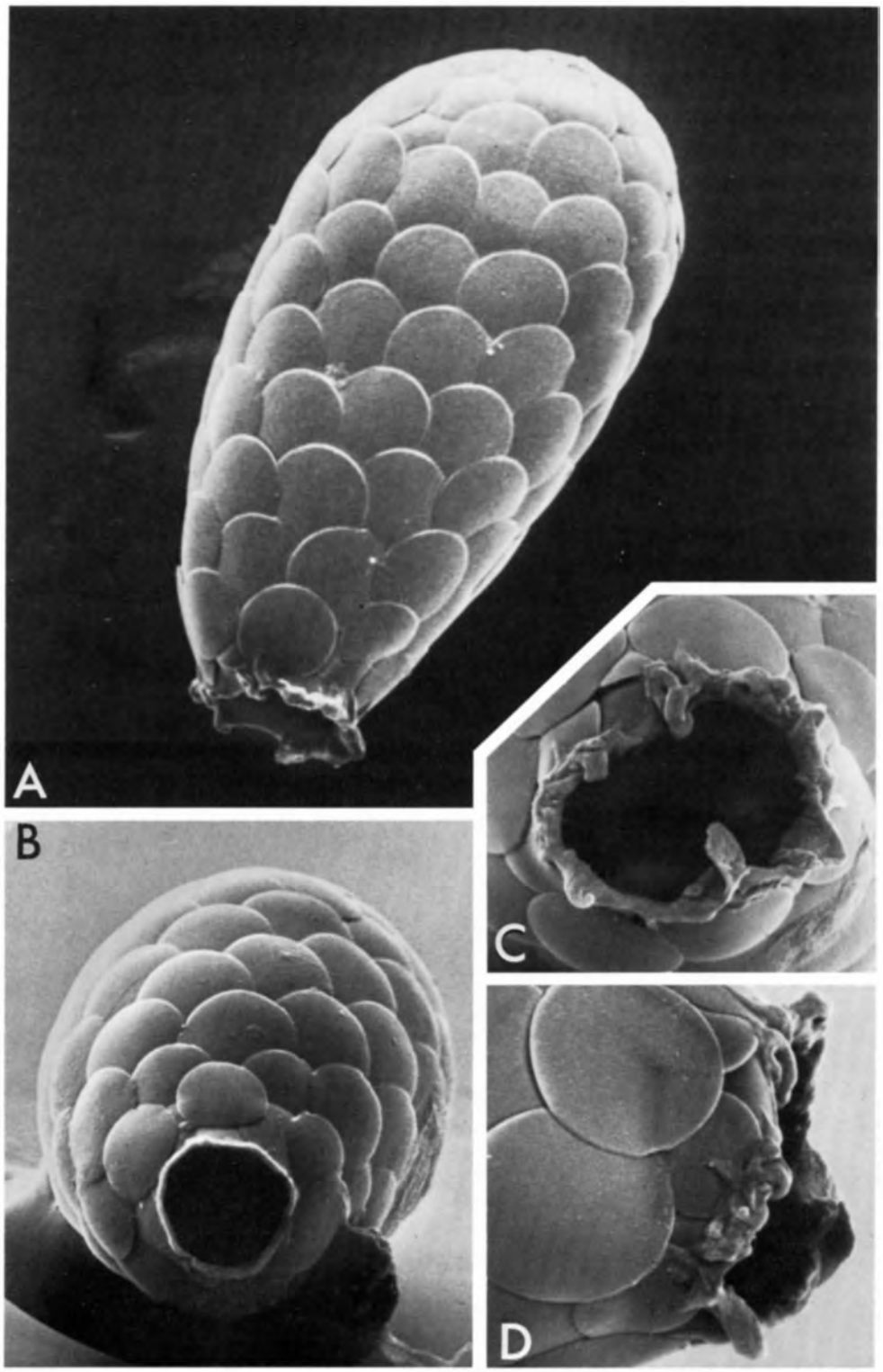
MEASUREMENTS (in μm)

Author	Shell length	Shell width	Diameter of aperture	Diameter of shell-plates
Cash *et al.*, 1915	35–61	20–33	8–13	5–9
present work n=6	52–61	29–31	8.8–11.5	6.6–8.8

GEOGRAPHICAL DISTRIBUTION Austria, Belgium, British Isles, Bulgaria, Congo, Costa Rica, France, Germany, Iceland, Java, Marion I., Netherlands, Poland, Roumania, Russia, Sweden, Switzerland, United States of America.

REFERENCES Chardez, 1961*a*; Decloitre, 1965; Deflandre, 1928*b*; Godenau *et al.*, 1973; Golemansky, 1970, 1974*b*; Grospietch, 1971; Hoogenraad & Groot, 1940*a*, 1946; Jung, 1936*a*; Laminger, 1972*a*, 1972*c*, 1973*b*, 1975; Schönborn, 1975; Štěpánek, 1963.

Fig. A Lateral view × 1750
Fig. B Apertural view × 1800
Fig. C Aperture with tooth-like projections × 2850
Fig. D Lateral view of aperture × 3600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Trinema enchelys (Ehrenberg, 1838)

DESCRIPTION The shell is ovoid and flattened slightly in the apertural region. It is composed of approximately fifty, large, circular, incompletely overlapping shell-plates and an unknown number of smaller, oval, shell-plates (Fig. A). The aperture is circular, sub-terminal and invaginated (Fig. B). It is bordered by an inner circle of about forty denticulate apertural-plates, and two or three rows of small, oval, shell-plates (Figs. C and D). Each apertural-plate is circular, and carries a median, dorsal tooth.

Both Chardez (1956) and Thomas (1958) have shown the differences in the shape and size of the shell of this species.

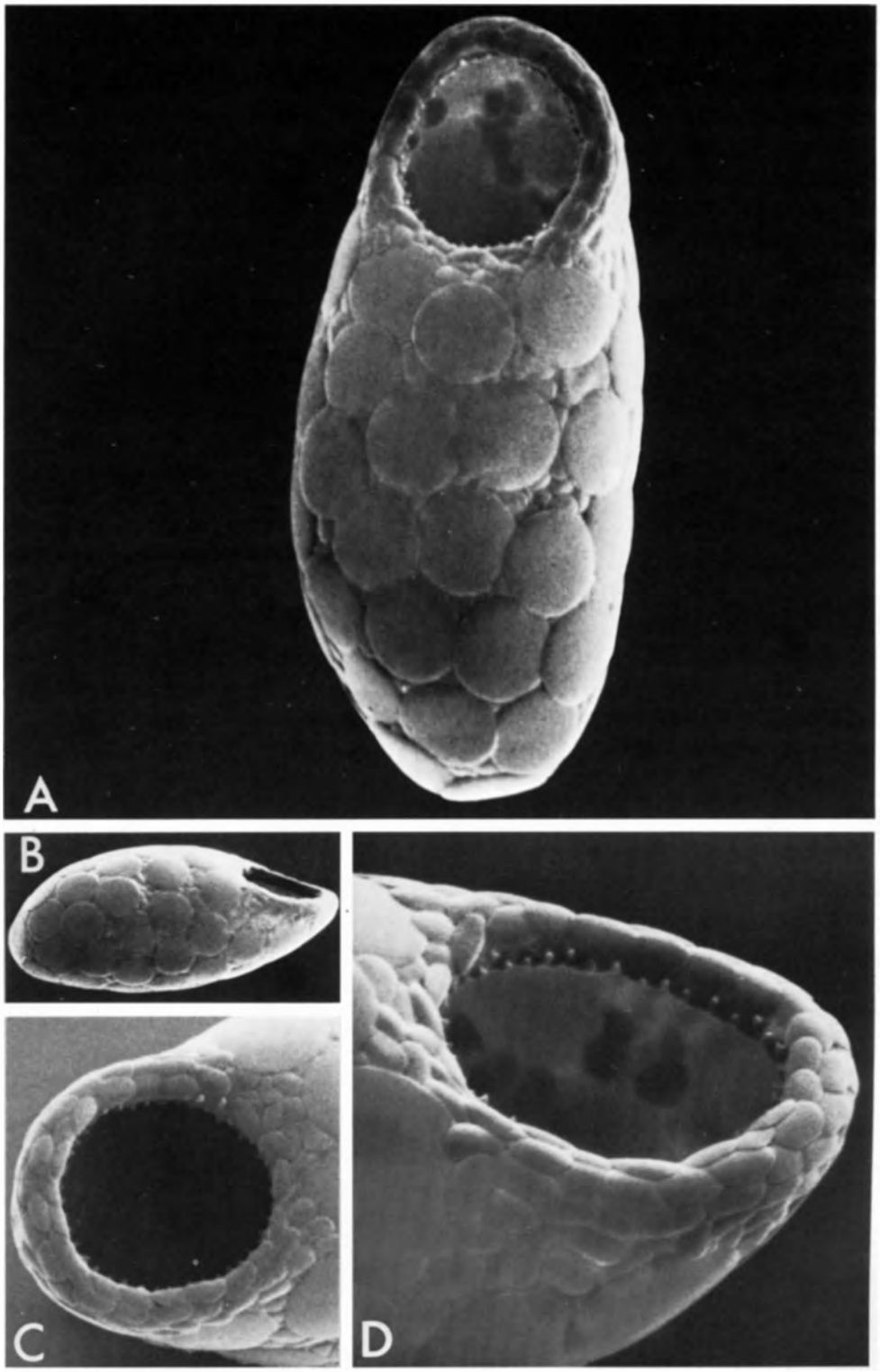
MEASUREMENTS (in μm)

Author	Shell		Diameter of aperture	Diameter of		Diameter of apertural plates
	length	width		large shell-plates	small shell-plates	
Cash *et al.*, 1915	32–103	15–60	6–20	4–12		
present work n = 13	47–78	19–34	11–20	5.6–10.3	1.9–4.3	0.9–1.8

GEOGRAPHICAL DISTRIBUTION Angola, Annobón I., Austria, Balearic I., Belgium, Brazil, British Isles, Bulgaria, Canada, Canary I., Cape Horn, Chile, Congo, Costa Rica, Czechoslovakia, Elephant I., France, Germany, Greece, Greenland, Guatemala, Iceland, India, Italy, Java, Marion I., Mexico, Morocco, Netherlands, Poland, Roumania, Russia, Senegal, Signy I., Spain, Spitzbergen, Sweden, Switzerland, United States of America, West Africa.

REFERENCES Bonnet, 1960, 1966, 1967*a*, 1967*b*; Chardez, 1956; Decloitre, 1947, 1951, 1961*b*, 1965, 1966; Godenau *et al.*, 1973; Golemansky, 1973, 1974*b*; Gracia, 1963, 1965*a*, 1965*b*; Green, 1975; Grospietch, 1971; Hoogenraad & Groot, 1946; Laminger, 1973*b*, 1975; Lousier, 1976; Nair & Mukharjee, 1966; Puytorac *et al.*, 1972; Rampi, 1947; Schönborn, 1975; Smith, 1972, 1973*a*; Štěpánek, 1963, 1967.

Fig. A Apertural view × 1300
Fig. B Lateral view × 500
Fig. C Aperture showing border of small shell plates × 1500
Fig. D Lateral view of aperture × 2400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Trinema lineare Penard, 1890

DESCRIPTION The ovoid shell is composed of approximately fifty, large, circular, incompletely overlapping, shell-plates, and an unknown number of small, oval to circular, shell-plates which either haphazardly fill the interstices or are completely overlaid by the large shell-plates (Figs. A and C). The aperture is normally circular, invaginated and situated sub-terminally. It is bordered by an inner circle of from 18 to 28 small, denticulate apertural-plates and one or two rows of small shell-plates (Figs. B and D). The apertural-plates may occasionally be moved from their marginal position to form double rows, or to be displaced out of symmetry.

Cash *et al.* (1915), Chardez (1956, 1970) and Thomas (1958) have illustrated variation in the position of the aperture, including examples of evaginated apertures. Whilst, in clonal cultures several abnormal forms have been observed (Hedley and Ogden, 1974*a*).

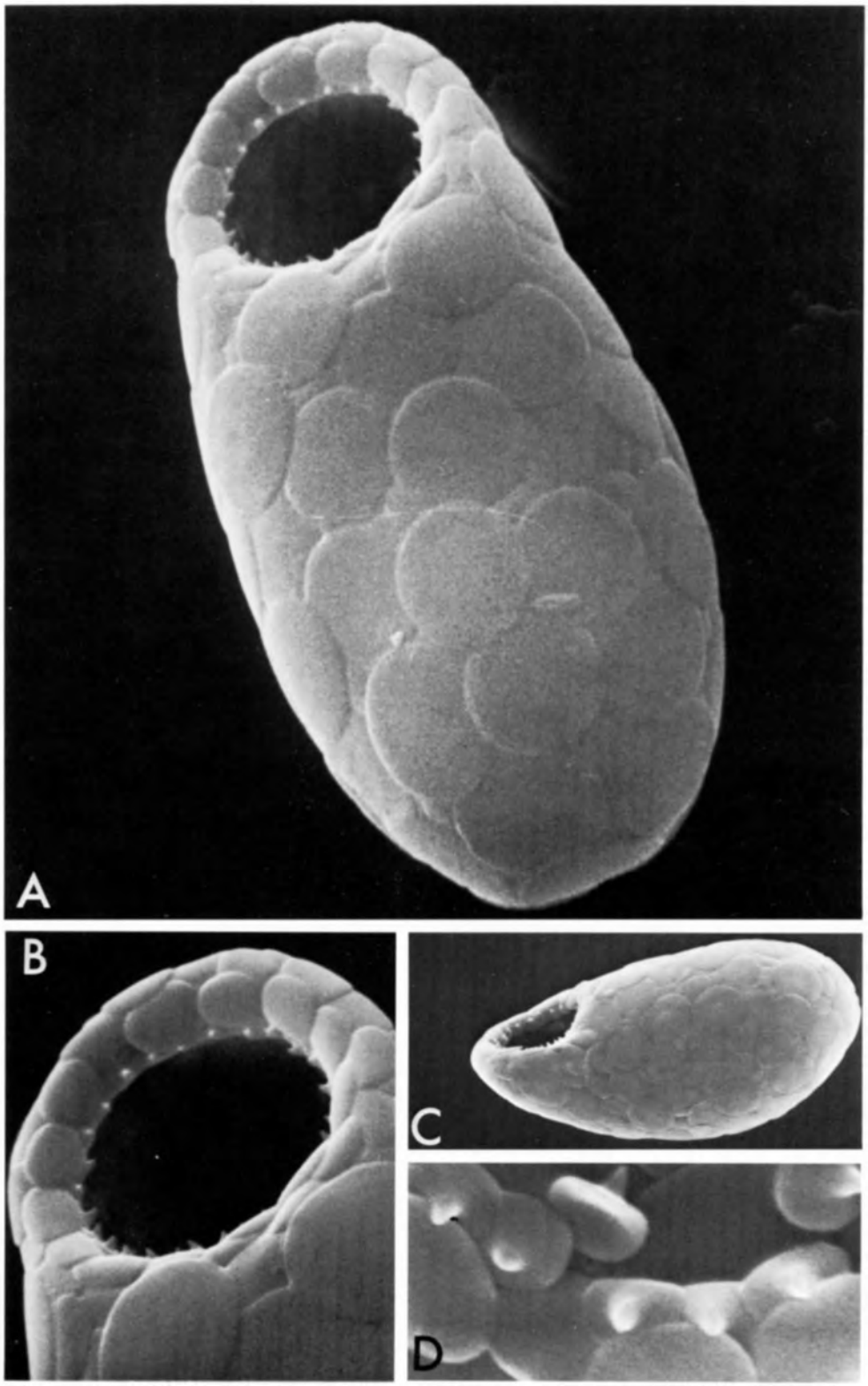
MEASUREMENTS (in μm)

Author	Shell length	Shell width	Diameter of aperture	Diameter of large shell-plates	Diameter of small shell-plates	Diameter of apertural plates
Cash *et al.*, 1915	18–35	7–17	3–6	3–6		
Hedley and Ogden, 1974*a* n = 100	25–35	14–19	6–8.5	4–5.5	2.4–3.5	1.2–1.5

GEOGRAPHICAL DISTRIBUTION Algeria, Angola, Annobón I., Australia, Austria, Balearic I., Belgium, Bolivia, Brazil, British Isles, Bulgaria, Canada, Canary I., Chile, China, Congo, Costa Rica, Czechoslovakia, Elephant I., Finland, France, Germany, Gough I., Greece, Greenland, Guatemala, Hungary, Iceland, India, Italy, Japan, Java, Marion I., Mexico, Morocco, Netherlands, New Guinea, New Zealand, Poland, Russia, Seychelles, Signy I., South Georgia, Spain, Spitzbergen, Sweden, Switzerland, Tasmania, Tristan de Cunha, United States of America, West Africa.

REFERENCES Bonnet, 1960, 1966, 1967*a*, 1967*b*; Chardez, 1956, 1970, 1972; Decloitre, 1947, 1951, 1961*b*, 1965; Golemansky, 1973, 1974*b*; Gracia, 1963, 1965*a*, 1965*b*, 1968*a*; Grospietch, 1971; Hedley & Ogden, 1974*a*; Hoogenraad & Groot, 1946; Laminger, 1973*b*, 1975; Lousier, 1976; Mercier *et al.*, 1964; Schönborn, 1975; Smith, 1972, 1973*a*; Štěpánek, 1963, 1967.

Fig. A Latero-apertural view × 4300 Fig. B View of aperture × 5400
Fig. C Lateral view × 1800
Fig. D Preparation illustrating the arrangement of apertural and shell plates × 9500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Corythion dubium Taránek, 1881

DESCRIPTION The shell is ovoid and composed of approximately four hundred oval shell-plates (Figs. A and D). The shell-plates usually overlap, and are often arranged haphazardly so that many are either incompletely or completely covered (Fig. A). The aperture is sub-terminal, oval and invaginated (Fig. B). About thirty small, oval, apertural-plates surround the aperture and each carries a median dorsal tooth (Figs. B and C). These apertural-plates are similar to those seen in *Trinema enchelys* and *T. lineare*.

Differences in the size of the shell are illustrated by Cash *et al.*, (1915).

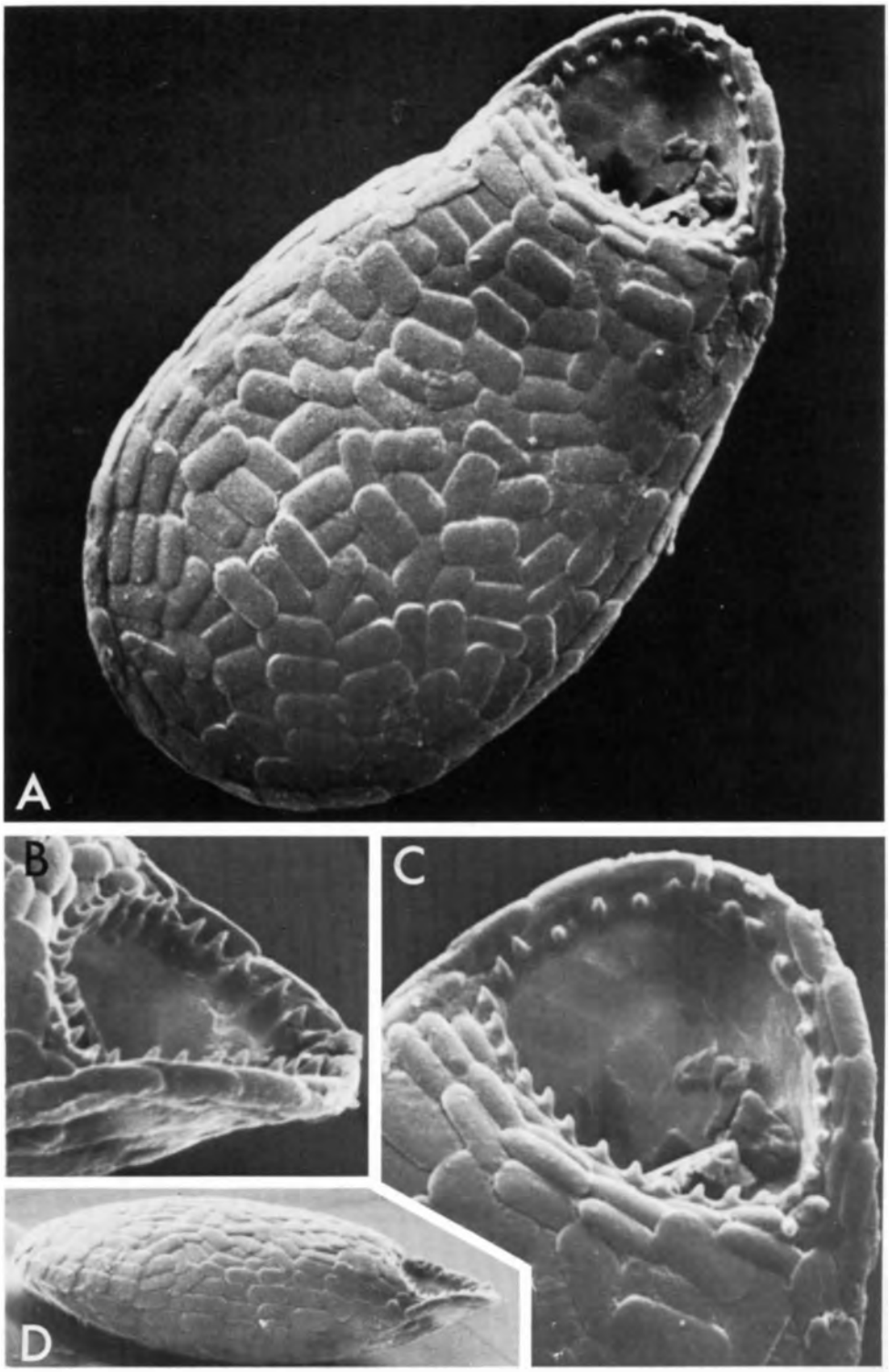
MEASUREMENTS (in μm)

Author	Shell		Diameter of aperture	Shell-plates		Diameter of apertural-plates
	length	width		length	width	
Cash *et al.*, 1915	23–65	16–40	5–16			
present work n=3	33–55	24–33	9–17	2.9–3.4	1.5–1.9	0.9–1.1

GEOGRAPHICAL DISTRIBUTION Angola, Annobón I., Austria, Belgium, British Isles, Bulgaria, Canada, Canary I., Chile, Costa Rica, Elephant I., France, Germany, Greece, Greenland, Guatemala, Iceland, Italy, Java, Marion I., Mexico, Nepal, Netherlands, Poland, Russia, Signy I., Spain, Spitzbergen, Sumatra, Sweden, Switzerland, United States of America.

REFERENCES Bonnet, 1960, 1966, 1967*a*, 1967*b*; Chardez, 1961*a*; Decloitre, 1965; Golemansky, 1970, 1973, 1974*b*; Gracia, 1963, 1965*b*, 1972; Grospietch, 1971; Hoogenraad & Groot, 1940*a*, 1940*b*, 1946; Laminger, 1972*b*, 1973*a*, 1973*b*, 1975; Lousier, 1976; Mercier *et al.*, 1964; Puytorac *et al.*, 1972; Rampi, 1947; Smith, 1972, 1973*a*, 1973*b*.

Fig. A Broad lateral view × 2500
Fig. B Lateral view of aperture × 4400
Fig. C View to show arrangement of shell plates around the aperture × 4500
Fig. D Narrow lateral view × 1600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Cyphoderia ampulla (Ehrenberg, 1840)

DESCRIPTION The shell is colourless or yellow, retort-shaped and circular in transverse section (Fig. A). It is composed of circular or oval, flattened, siliceous shell plates, which are arranged in diagonal rows on an organic matrix so that they either lie close or touch, but do not overlap (Fig. C). The aperture is circular and surrounded by a row of shell plates (Figs. B and D).

The specimen with a papillose aboral region that we examined, did not vary in any other respect from specimens identified as *C. ampulla*, and it is included in the list of measurements, although Wailes (1913) describes it as a variety *C.a. papillata*. *C. ampulla* differs from *C. trochus* in having smaller shell plates that do not overlap.

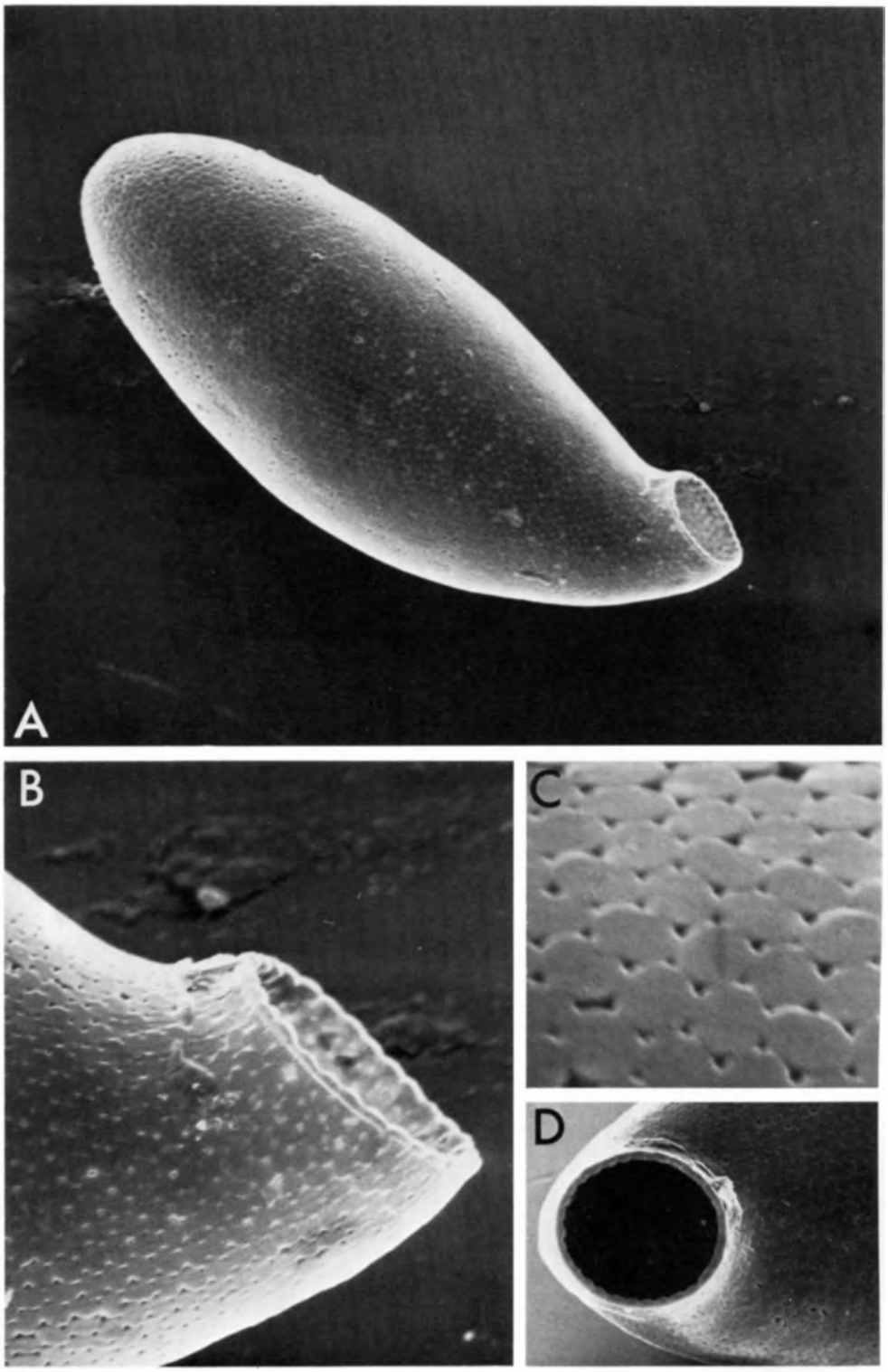
MEASUREMENTS (in μm)

Author	Length of shell	Diameter of shell	Diameter of aperture	Diameter of shell plates
Cash *et al.*, 1915	61–190	33–72	10–22	1.5–2.5
present work n = 4	87–135	34–51	13–17	1.9–2.4

GEOGRAPHICAL DISTRIBUTION Austria, Belgium, British Isles, Bulgaria, Canada, Chile, Congo, Czechoslovakia, Faroes, France, Germany, Greece, Iceland, Netherlands, Poland, Roumania, Russia, Sweden, Switzerland, United States of America, Venezuela.

REFERENCES Bonnet, 1966, 1967*b*; Chardez, 1961*a*; Decloitre, 1965; Godenau *et al.*, 1973; Golemansky, 1973, 1974*b*; Grospietch, 1975; Jung, 1936*a*; Laminger, 1972*c*; Lousier, 1976; Puytorac *et al.*, 1972; Schönborn, 1975; Štěpánek, 1963, 1967.

Fig. A Lateral view × 820
Fig. B Lateral view of aperture × 2400
Fig. C Portion of shell × 6700
Fig. D View of aperture × 1300


A
B
C
D

Cyphoderia trochus Penard, 1899

DESCRIPTION The shell is colourless or yellow, retort-shaped and circular in transverse section (Fig. A). It is composed of circular, bi-convex, siliceous shell plates, which overlap each other and are arranged in diagonal rows (Fig. B). The aperture is circular and surrounded by a ring of shell-plates (Figs. C and D).

Specimens with the aboral region either pointed or flattened have been described as varieties of *C. trochus*, however, we regard such variation to be intraspecific. The degree of imbrication of the shell plates and the length of the neck also appear to vary. The measurements taken from Cash *et al.*, (1915) are those for *C. trochus* var. *amphoralis*.

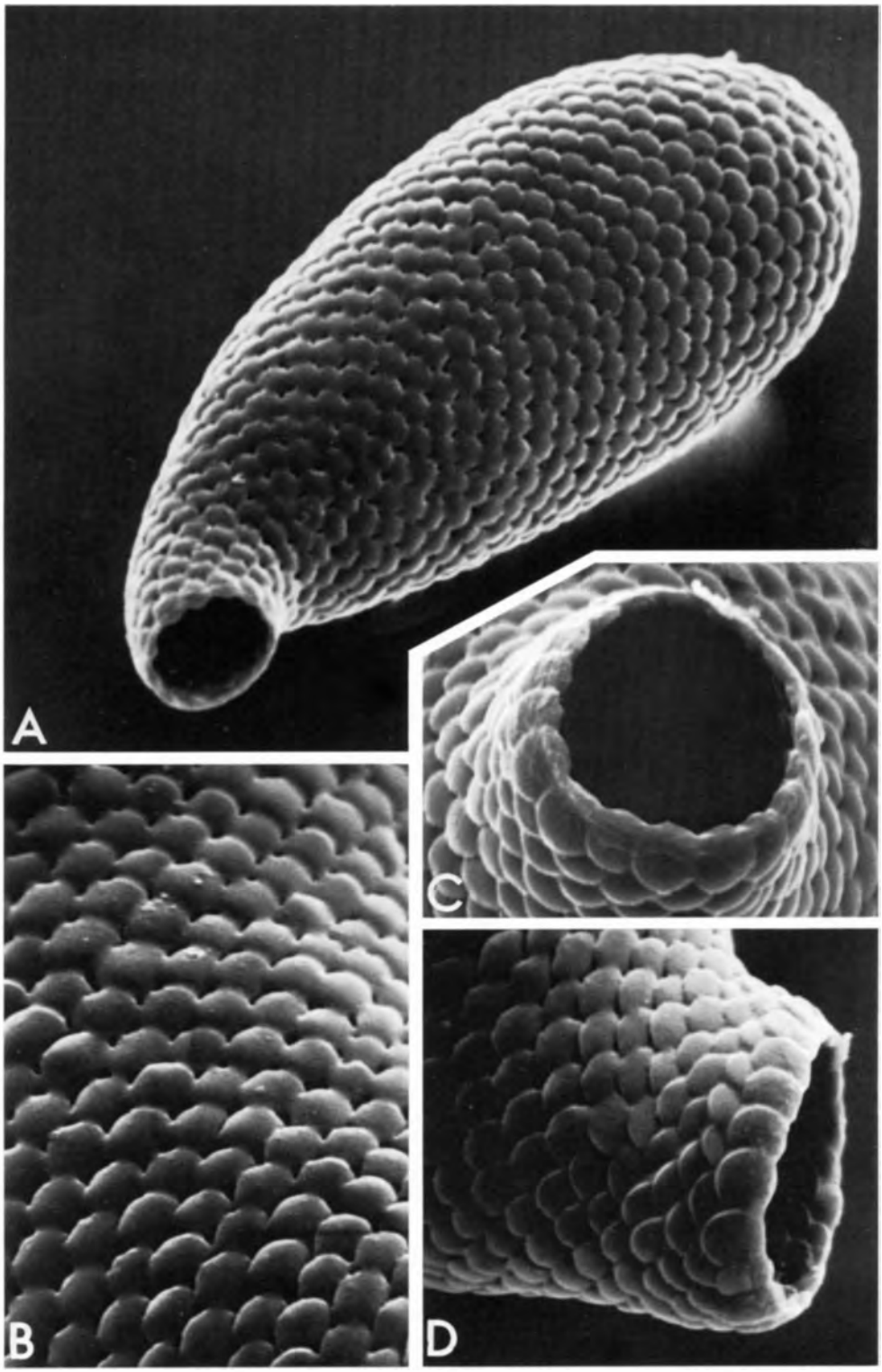
MEASUREMENTS (in μm)

Author	Length of shell	Diameter of shell	Diameter of aperture	Diameter of shell plates
Cash *et al.*, 1915	87–153	38–52	12–20	2.8–5.
present work n = 14	105–137	35–55	14–19	3.0–3.5

GEOGRAPHICAL DISTRIBUTION Austria, British Isles, Czechoslovakia, Germany, Hungary, Russia, Sweden, Switzerland, Venezuela.

REFERENCES Gal, 1969; Grospietch, 1975; Laminger, 1972*c*; Schönborn, 1975; Štěpánek, 1967.

Fig. A Lateral view × 1100
Fig. B Portion of shell showing overlapping shell plates × 2400
Fig. C Apertural view × 2500
Fig. D Lateral view of aperture × 2400


A
B
C
D

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Index to Genera and Species

Numbers in bold type indicate pages on which illustrations are given

This book illustrates, using scanning electron micrographs, most of the common species of testate amoebae that are found in freshwater habitats. Information on the biology, ecology, geographical distribution and a classification are followed by descriptions of ninety-five species. Each of these is illustrated by several views of the shell.

The text is designed not only to enable biologists to identify species of testate amoebae, but to serve as an introduction to students interested in the taxonomy and biology of these freshwater protozoa. It will be of special interest to protozoologists, ecologists, limnologists, water treatment specialists and micropalaeontologists interested in recent sediments.

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