

The dinoflagellate cyst genus *Polygonifera*; emendation and taxonomic stabilization

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ABSTRACT—The taxonomic identity of the dinoflagellate cyst genus *Polygonifera* Habib, 1972 is confirmed, through the recognition of additional morphological characters during the study of specimens from Early-Middle Cretaceous sediments of India. A revised definition of this genus is presented. *Leberidocysta* Stover & Evitt, 1978 is considered a subjective junior synonym of *Polygonifera* and its type species *Leberidocysta* (ex: *Hexagonifera*) *chlamydata* (Cookson & Eisenack) is transferred to *Polygonifera*. The other species placed in *Leberidocysta* are provisionally reattributed to other genera, becoming *Craspedodinium* (ex: *Hexagonifera*) *defloccata* (Davey), *Craspedodinium* (ex: *Palaeostomocystis*) *pergamentacea* (Burger), *Hexagonifera* *laticaudata* Vozzhennikova and *Hexagonifera* *scabrata* Jain & Taugourdeau-Lantz. A new species, *Polygonifera* *eisenackii*, is described. Morphological differences between the camocavate genera *Polygonifera* and *Dingodinium* are clarified.

HISTORICAL BACKGROUND

Cookson & Eisenack (1961, p. 73) erected the genus *Hexagonifera* and defined it as "Shell oval, wall of variable thickness, smooth or ornamented. Pylome formed by the removal of a 6-sided lid at one pole." They placed two species into this genus: *H. glabra* (Pl. 12, figs. 9–13, p. 74) and *H. vermiculata* (pl. 12, figs. 6–8, p. 74), the former being selected as the type. *H. glabra* was described thus: "Shell thick walled, smooth, homogeneous, occasionally perforated by straight narrow pores. Lid 6-sided, usually with 3 short and 3 long sides in alternation." A little later these authors emended the genus to include cavate forms and described a third species, *H. chlamydata* (Cookson & Eisenack, 1962, p. 496, pl. 7, figs. 1–3, 5–8). This species is characterised by its thick endophragm, having a verrucose ornamentation, and its thinner, smooth periphragm.

Habib (1972, p. 376) erected the genus *Polygonifera* for camocavate dinoflagellate cysts with an apical archaeopyle and a polygonal to oval ambitus, naming *Polygonifera* *evittii* as type species. This is characterised by its distinct cingulum and scabrata to granulose cyst ornamentation (*ibid.*, pl. 5, figs. 1–2). Habib distinguished *Polygonifera* from *Hexagonifera* on the basis of presence of a "distinct" cingulum in *Polygonifera*, a character not observed in *Hexagonifera*.

Lentin & Williams (1976, p. 84), in their monograph on fossil peridinioid dinocysts, discussed the archaeopyle types in the various species assigned to *Hexagonifera* by Cookson & Eisenack (1961, 1962). The archaeopyle type in *H. glabra* was interpreted as intercalary, of hexa 2a type. Further, they doubted the generic assignment of *Hexagonifera chlamydata*, since the nature of the

archaeopyle in the illustrations of Cookson & Eisenack (1962, p. 496, pl. 7, figs. 1–3, 5–8) appeared to be apical. However, they retained this species in *Hexagonifera*, pending confirmation of its having an apical archaeopyle.

Stover & Evitt (1978, p. 107–108), in their general analysis of fossil dinoflagellates, emended the genus *Hexagonifera* to include only proximate cysts having an intercalary archaeopyle, a character seen only in the type species *H. glabra*. The character of archaeopyle in *Hexagonifera chlamydata* was confirmed as apical (*ibid.*, p. 60). This interpretation is fully acceptable to us, for not only do the illustrations of Cookson & Eisenack (1962, pl. 7, figs. 1–3, 5–8) clearly suggest an apical archaeopyle in this species but also our examination of a colour transparency of the holotype (No. 123 in the series prepared for sale by Helby & Partridge, 1980) supports their conclusion. A cavate genus, *Leberidocysta*, was proposed by Stover & Evitt (*ibid.*, p. 59–60) for cavate cysts having an apical archaeopyle, *Leberidocysta chlamydata* (Cookson & Eisenack) being selected as its type species.

Stover & Evitt (1978, p. 75) suggested further that *Polygonifera* might prove to be a junior synonym of *Dingodinium* Cookson & Eisenack, 1958, noting the similarity in the nature of their cyst cavation (camocavate). They added that the archaeopyle type in *Dingodinium* and the possible presence of an apical horn in *Polygonifera* needed to be determined, to test this hypothesis.

MORPHOLOGY OF THE POLYGONIFERA- LEBERIDOCYSTA GROUP

In our study of Early-Middle Cretaceous subsurface sediments of Perivadavadi shallow well-1, Cauvery

basin, south India, a large number of well preserved specimens were encountered resembling *Polygonifera* and the type species of *Leberidocysta*, *L. chlamydata*, in shape, nature of cyst cavation and archaeopyle characters. Specimens with operculum detached were most commonly observed, though individuals with an attached operculum were not rare. The archaeopyle, as observed in *Polygonifera* and in the type species of *Leberidocysta*, *L. chlamydata*, is definitely apical.

Preservation of specimens in different orientations results in an apparently variable degree of pericoel development. The frequent folding of the periphragm and its degree of preservation, together with variable cyst flattening, makes the morphology of these dinocysts appear unduly complex. Nevertheless, this provides an excellent opportunity to study their morphological characteristics in greater detail. Our observations are:

Shape

Specimens, when orientated in dorsoventral position, exhibit generally a polygonal to subpolygonal (Figs. 2a, b, 3a) or even oval (Figs. 1a, 3b) periblast and an oval endoblast. In lateral compressions, both periblast and endoblast appear oval (Figs. 1b, c, 2c). Similar observations were made by Habib (1972, p. 376), when describing the type species *P. evittii*. No apical horn is seen, though a small "notch" or mamelon may appear to be present on the apical region, due to periphragm folding (Fig. 1b).

Cavation

The cyst is camocavate. The apparent degree of pericoel development is greatly affected by periphragm preservation (being delicate, it is often torn or incompletely preserved) and folding. The pericoel may be well developed (Figs. 1b, c, 2a, b, c, 3a, b) or only partially developed (Figs. 1a, d). In many cases the periphragm may not be preserved at all, or may be apparently developed only in the antapical region (Pl. 2, fig. 6).

Stover & Evitt (1978, p. 75), analysing the genus *Polygonifera* on the basis of published illustrations of its type species *P. evittii*, concluded that the periblast remained attached to the endoblast along the dorsal surface only. Our own observations agree with this. However, in view of the absence of either a clear sulcal notch or parasutural features, our interpretation, and also the orientation of specimens illustrated in this study, cannot be considered conclusively established. Regarding the orientation of the specimens of *Polygonifera* examined in the present study, we believe them to be most commonly preserved either in slightly oblique dorsal (Figs. 2a, b, 3a, b) or ventral views (Fig. 2), though lateral compressions are also not uncommon (Figs. 1b, c, d, 2c).

Archaeopyle

The archaeopyle is formed by the loss of all the paraplates of the apical series, these being removed as a simple operculum. The number of paraplates appears to be four, as suggested by the occasional partial development of accessory archaeopyle sutures (Figs. 1a; Pl. 2, fig. 4). Rarely, only the anterior piece of the operculum on the ventral surface is lost in archaeopyle development, the dorsal section remaining attached (Fig. 1b; Pl. 2, fig. 7).

The archaeopyle margin is usually zigzag. Habib (1972, p. 376), studying this feature in *P. evittii*, considered a sulcal notch and six precingular paraplates to be indicated (*ibid.*, pl. 5, figs. 1, 2). Though a sulcal notch could not be unequivocally recognised in any specimen in the present assemblage, its possible position is suggested in a few (see Fig. 1a; Pl. 2, figs. 4, 6). The character of the archaeopyle in the Indian specimens is not sufficiently clear for us to determine with confidence the number of precingular paraplates.

Specimens are most often found with their operculum detached. In this case, both peripyle and endopyle can be clearly distinguished (Figs. 1a, 2a, b, 3a, b; Pl. 1, figs. 1, 2, 5, 7). Specimens with an attached operculum are also not rare. In such instances both perioperculum and endoperculum are usually distinguishable (Figs. 1c, 2c; Pl. 1, figs. 3, 4, 6; Pl. 2, fig. 5). In a few cases the perioperculum is free, while the endoperculum remains attached (Fig. 1d; Pl. 2, figs. 2, 3).

Paratabulation

Parasutural features are usually not well developed. However, one species assigned to this genus does exhibit a fairly full paratabulation. This is *Polygonifera* (ex: *Meiourogonyaulax*) *staffinensis* (Gitmez, 1973, p. 276–278, pl. 3, fig. 2; text-fig. 20) Davey, 1982, p. 31, which reflects the paratabulation: '?', '?0a, 6", 6c, 6"', '2p, 1pv, 1"', either by means of elevated crests on a murochorate central body, as interpreted by Gitmez herself (*op. cit.*) or by crests on the endoblast of a camocavate cyst, as seems to be Davey's interpretation. The latter, more recent conclusion is here accepted as correct for purposes of discussion; however, Davey's re-interpretations of the morphology of this species is unsupported by illustrations and must be considered unproven, pending a re-examination of the holotype.

Claustrum

A small, regularly or irregularly shaped opening of variable size, corresponding to a claustrum (see Norris, 1978), may be present on the hypocyst. Its position is variable; it may be situated just below the cingulum (Fig. 1b) or close to the antapex (Fig. 1c). Its irregularity of shape and position casts some doubt upon this being a preformed opening; the possibility of its being the work of a scavenger or predator cannot be excluded.

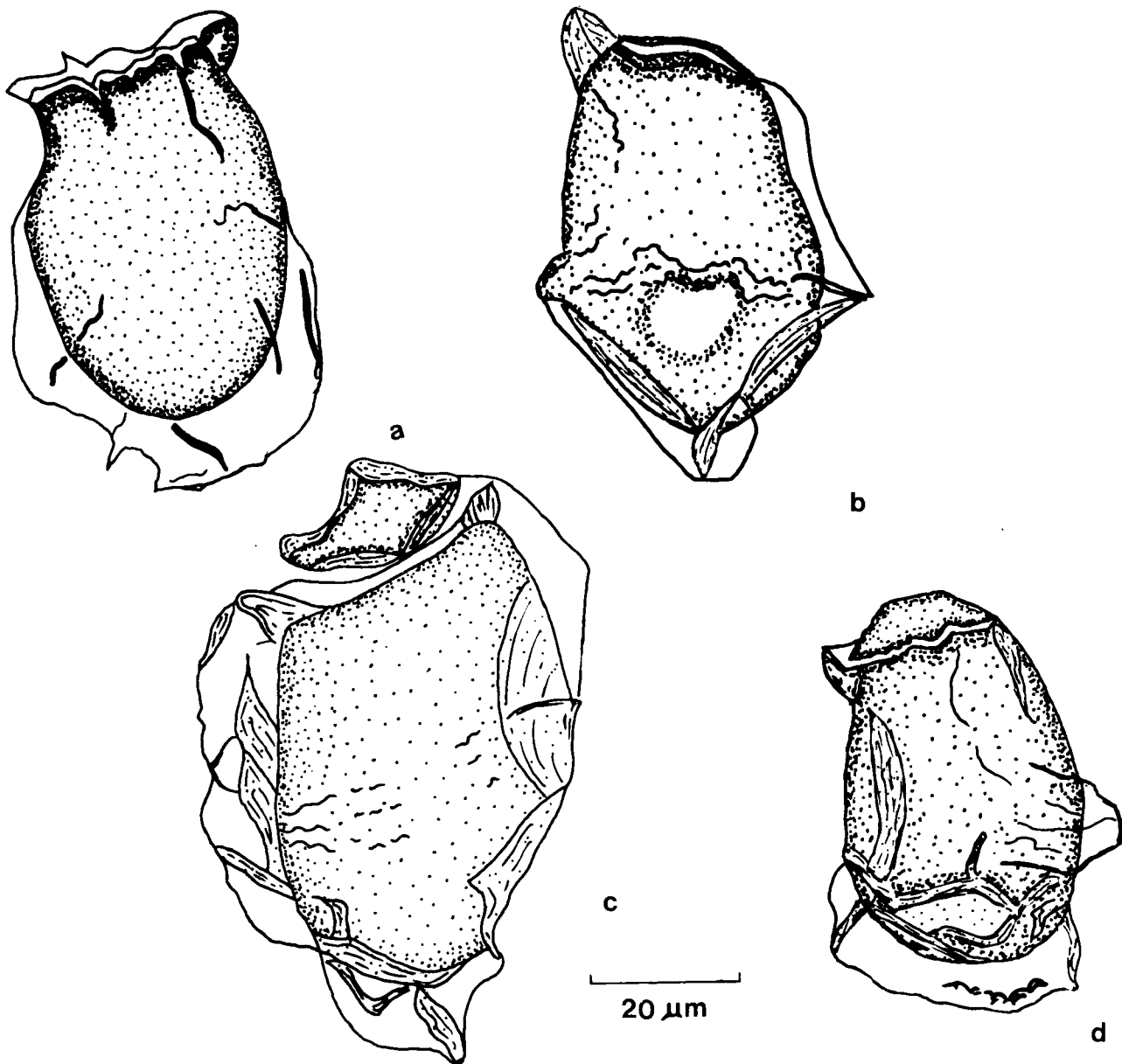


Fig. 1. *Polygonifera eisenackii* sp. nov.

- a. Slide IPEP/PVD/31/5 (108–110 m); paratype a in ventral view; note accessory archaeopyle parasutures. (See also Pl. 2, fig. 4).
- b. Slide IPEP/PVD/31/4 (108–110 m); specimen in left lateral view; note position of cingulum, claustrum as seen below the cingulum on the hypotract and an apical mamelon formed by the periphragm folding. It appears that the archaeopyle is formed by the loss of only anterior part of the operculum on the ventral surface, part of the operculum on the dorsal surface remaining attached. (See also Pl. 2, fig. 7).
- c. Slide IPEP/PVD/25/4 (95–97 m); holotype in oblique lateral view. Note the position of the cingulum, as indicated by periphragm folding, and the attached endoperculum and perioperculum. (See also Pl. 1, fig. 6).
- d. Slide IPEP/PVD/31/4 (108–110 m); specimen in left lateral view. Note the attached endoperculum and free perioperculum, the periphragm folding and the position of the cingulum on the cyst margin. (See also Pl. 2, fig. 3).

[In all the figures, the shading is to clarify the character of archaeopyle and cyst cavation. It does not suggest cyst ornamentation].

Cingulum

The presence of a cingulum has been noted frequently in Indian specimens, though the degree of its development is variable. Folding of the periphragm may indicate either:

- 1) a distinct and well developed cingulum (Pl. 1, figs. 1–5, 7; Pl. 2, fig. 7; see also Figs. 1b, 2b, 3a–b);
- 2) a faint or incomplete cingulum (Pl. 1, fig. 6; Pl. 2, figs. 1–3, 5; see also Figs. 1c, 2a, c), or
- 3) the cingulum may not be visible at all (Pl. 2, figs. 4, 6; see also Fig. 1a).

The cingulum, when completely developed, occupies the maximum width of the cyst body (a feature observed also by Habib, 1972, p. 376). It divides the cyst into a large epitract and a smaller hypotract.

To overcome present problems in establishing the taxonomic identity of these dinocysts, it is necessary to recognise that the degree of development of the cingulum in *Polygonifera* is a variable, and not a constant, character, unsuitable as a means for generic separation. In consequence, we consider that the genus *Leberidocysta*, differentiated only on this character, should not be maintained and that its type species, *L. (ex: Hexagonifera) chlamydata*, should be transferred to *Polygonifera*.

The other species attributed to *Leberidocysta* by Stover & Evitt (1978, p. 60) do not exhibit the morphological characters of *Polygonifera*; they are discussed later.

Sulcus

This feature is not usually developed, its position being suggested only by the sulcal notch. Only in *Polygonifera staffinensis* (Gitmez) is the sulcus relatively readily discernible. However, as noted earlier, we have reservations concerning the allocation of that species to this genus.

SYSTEMATIC DESCRIPTIONS

Order Peridiniales Haeckel

Suborder Hystrichosphaeridiineae Norris, 1978

Family Senoniasphaeraceae Norris, 1978

Genus *Polygonifera* Habib, 1972, emend.

Leberidocysta Stover & Evitt, 1978

Type species. *Polygonifera evittii* Habib, 1972, p. 376, pl. 5, figs. 1, 2. Late Jurassic (Oxfordian-Kimmeridgian).

Emended diagnosis. Cysts camocavate, generally of intermediate to large size. Endoblast oval to ellipsoidal; periblast polygonal to oval. Apical horn lacking. Periphragm thin, delicate, frequently folded; endophragm comparatively thicker. Endoblast separated from periblast everywhere except on one side (?dorsal). The apparent size of the pericoel is largely a consequence of the degree of periphragm folding and preservation. Parasutural features usually not developed. When determinable, the paratabulation may be: 4', ?0a, 6'', 6c,

6''', 1–2p, 1pv, 1'''''. Endophragm smooth or ornamented with features of low to moderate relief; ornamentation may be of verrucose, granulose, reticulate, scabrate or punctate type. Periphragm generally smooth or faintly ornamented (reticulate, punctate or scabrate). Archaeopyle apical, type (4a); operculum may be free or attached. Cingulum feebly to clearly indicated; when clearly developed, it occupies the maximum cyst width. Sulcus generally not developed, indicated by a sulcal notch only. A claustrum may be present in the hypotract.

General archaeopyle formula: (4a)/(4a); after Evitt (1967), Lentin & Williams (1976) and Norris (1978).

Polygonifera eisenackii sp. nov.

(Pl. 1, figs. 1–7; Pl. 2, figs. 1–7; Figs. 1a–d, 2a–c, 3a–b)

Derivation of name. In honour of the late Prof. Alfred Eisenack.

Diagnosis. Cyst proximate, camocavate. Periblast polygonal-subpolygonal or oval in ambitus, oval in lateral view; endoblast oval to broadly ellipsoidal. Apical horn lacking; a small notch may develop in the apical region, due to periphragm folding. Periphragm thin, delicate; it may be fully, partially or not at all developed and, when present, is typically folded. Endophragm relatively thicker and typically not distorted. Both endophragm and periphragm are smooth or weakly ornamented (reticulate, foveoreticulate, or finely punctate). No parasutural features are present. Archaeopyle apical, (4a)/(4a); peripyle and endopyle are usually distinct. Operculum free or attached. Cingulum indicated by periphragm folding, sometimes distinct and completely developed, in other instances faintly, incompletely or not at all suggested. Typically, no indication of a sulcus is seen other than a poorly marked sulcal notch. A claustrum of variable size and shape may be present in the hypotract.

Holotype. Slide IPEP/PVD/25/4, Pl. 1, fig. 6; Fig. 1c.

Material. Paratype a. Slide IPEP/PVD/31/5, Pl. 2, fig. 4; Fig. 1a; paratype b. Slide IPEP/PVD/25/4, Pl. 2, fig. 1; Fig. 2a. The holotype, paratypes and all illustrated specimens are deposited in the K. D. Malaviya Institute of Petroleum Exploration, Dehra Dun, India. Supplementary material is lodged in the palynological collections of the University of Saskatchewan, Saskatoon, Canada.

Locality and horizon. Perivadavadi shallow well-1, Cauvery basin, South India (for holotype and both paratypes). Holotype and paratype b are from a claystone bed at depth 94–96 m (Core 25), Middle Cretaceous (Aptian); paratype 2 is from a claystone bed at depth 108–110 m (Core 31), Middle Cretaceous (Aptian).

Dimensions. Holotype (operculum attached); periblast 89 × 50 μm; endoblast 68 × 39 μm. Paratype a (operculum attached); periblast 55 × 40 μm; endoblast 45 × 32 μm. Paratype b (operculum attached); periblast

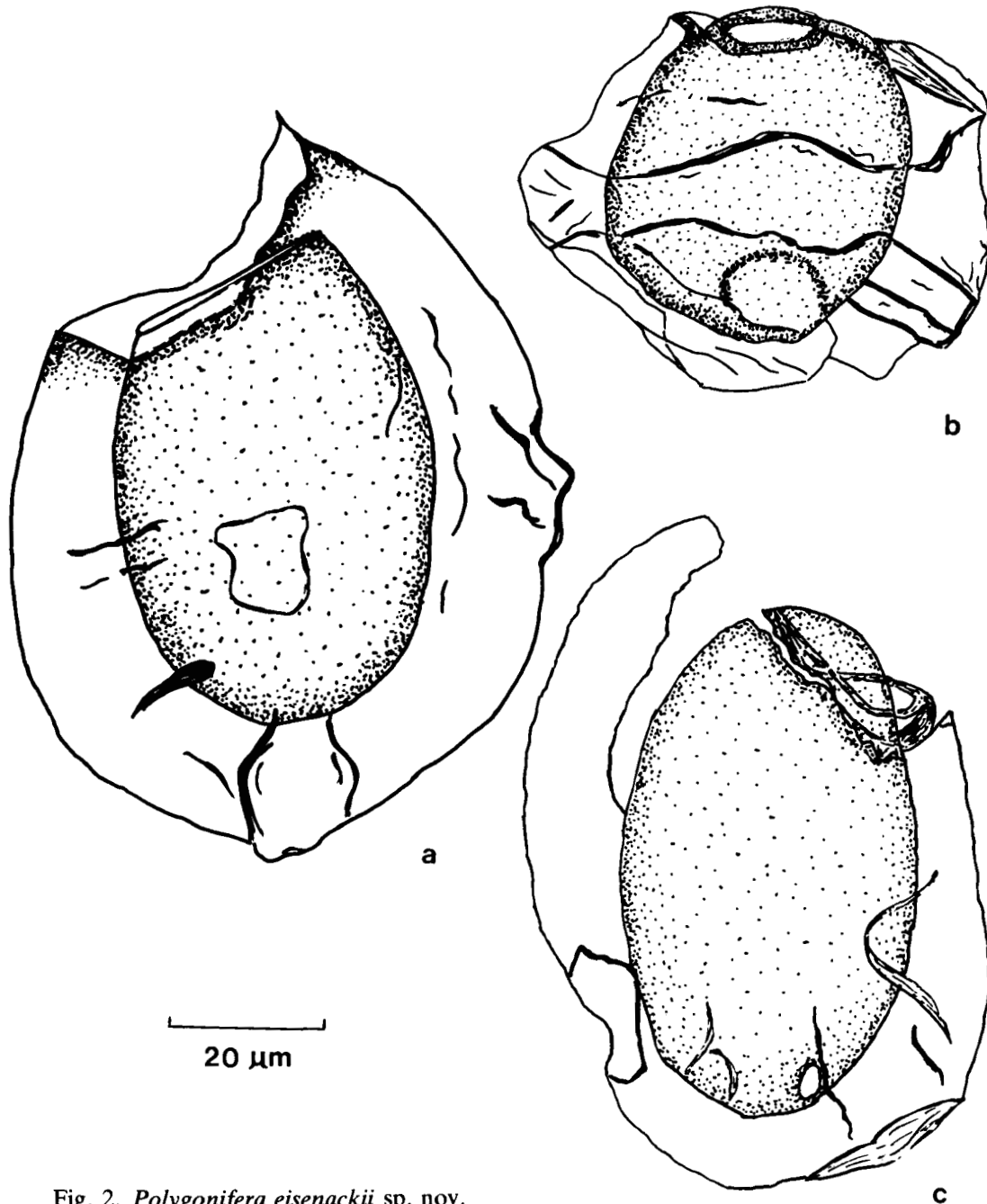


Fig. 2. *Polygonifera eisenackii* sp. nov.

- a. Slide IPEP/PVD/25/4 (95–95 m); paratype b in slightly oblique dorsal view. Both peripyle and endopyle are distinct and a cingulum faintly indicated along the cyst margin by periphragm folding. Note the subpolygonal outline of the periblast. (See also Pl. 2, fig. 1).
- b. Slide IPEP/PVD/37/5 (122–124 m); specimen in dorsal view. Note the peripyle and endopyle, the position of the cingulum (as indicated by periphragm folding) and the subpolygonal outline of the periblast. (See also Pl. 1, figs. 1,2).
- c. Slide IPEP/PVD/25/4 (95–97 m); specimen in (?) oblique lateral view. Both endopericulum and periopericulum are attached, but part of the periblast in the apical region is damaged. Note the indication of the cingulum on the cyst margin and a small opening in the hypotract. (See also Pl. 2, fig. 5).

[In all the figures, the shading is to clarify the character of archaeopyle and cyst cavation. It does not suggest cyst ornamentation].

92 × 63 μm; endoblast 61 × 45 μm. Range (operculum free); periblast 50 × 48 μm to 92 × 73 μm, endoblast 40 × 35 to 61 × 45 μm. A single specimen (Pl. 2, fig. 6) measured with periblast partially developed, endoblast complete with attached operculum; endoblast 42 × 37 μm. **Remarks.** This species is readily distinguishable from *P. evittii* and *P. (ex: Hexagonifera) chlamydata* by its laevigate to weakly ornamented endoblast. The endoblast ornamentation in *P. evittii* is scabrate to granulose and that in *P. chlamydata* is verrucose. The degree of development of the cingulum is variable in *P. eisenackii*, whereas the cingulum is well developed in *P. evittii* (Habib, 1972, pl. 5, figs. 1, 2) and not developed at all in *P. chlamydata* (Cookson & Eisenack, 1962, pl. 7, figs. 1–3, 5–8.).

Polygonifera eisenackii exhibits a broad size range. The holotype selected is a complete specimen with attached operculum and measures 89 μm (overall length). The two paratypes (a and b) have been selected to demonstrate the marked variation in size exhibited by this species. They represent extremes in their range, the overall length of paratype a being only 55 μm (operculum free) whereas paratype b attains 92 μm. It is conceivable that future studies may favour the subdivision of this species into two subspecies, based mainly on this difference in size.

Habib (1972, p. 376) gave the size range of the type species *P. evittii* as 42–62 μm, as measured on twelve specimens. It was, however, not indicated whether the specimens measured were complete or with detached operculum. Since the specimens from India, described above, are intermediate to large in size, we prefer to recognise the size range in *Polygonifera* as intermediate to large, and not small to intermediate as described by Stover & Evitt (1978, p. 75). Other species of *Polygonifera*:

Polygonifera chlamydata (Cookson & Eisenack, 1962, p. 496, pl. 7, figs. 1–3, 5–8) comb. nov., Middle–Late Cretaceous (Albian–Cenomanian). [Formerly *Hexagonifera* and *Leberidocysta*.]

Polygonifera staffinensis (Gitmez, 1970, p. 276–278, pl. 3, fig. 1; text-figs. 20a–b) Davey, 1982, p. 31. Upper Jurassic (Kimmeridgian). [Formerly *Meiourogonyaulax*.]

OTHER SPECIES FORMERLY PLACED IN *LEBERIDOCYSTA*

Leberidocysta defloccata (Davey & Verdier, 1973, p. 198, pl. 3, figs. 6, 8) was described as closely resembling *Hexagonifera chlamydata* (assigned herein to *Polygonifera*) in its overall appearance but differing in having a smooth inner body. A comparison of the photographs of the holotype of Davey & Verdier's species (1973, pl. 3, fig. 8) and that of *Hexagonifera chlamydata* (Cookson & Eisenack, 1962, pl. 7, fig. 2) reveals marked dissimilarities in their morphological characters. The former has a spherical endoblast and a roughly sub-spherical periblast, while the latter is characterised by having an oval endoblast and subpolygonal periblast. There is a marked difference in the size of endoblast and periblast in Davey & Verdier's specimen, while this is not the case in *Polygonifera (ex: Hexagonifera) chlamydata*. Further, whereas *Polygonifera chlamydata* is camocavate, this character is not obvious in *Hexagonifera defloccata*. Recognising these characters, we do not feel it proper to place Davey & Verdier's forms in *Polygonifera*. The precise placement of this species (previous assignments were to *Hexagonifera* Davey & Verdier, 1973, p. 198, pl. 3, figs. 6, 8; *Thalassiphora* Lentin & Williams, 1976, p. 85; and *Leberidocysta* Stover & Evitt, 1978, p. 60) can probably be best determined by re-examination of its type

Explanation of Plate 1

All figures are × 1024

Polygonifera eisenackii sp. nov.

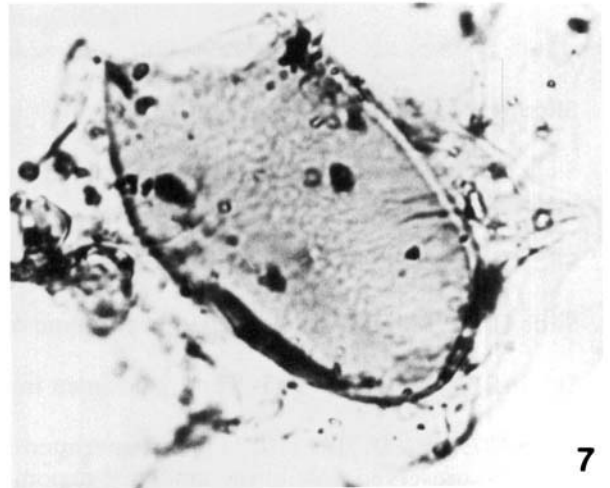
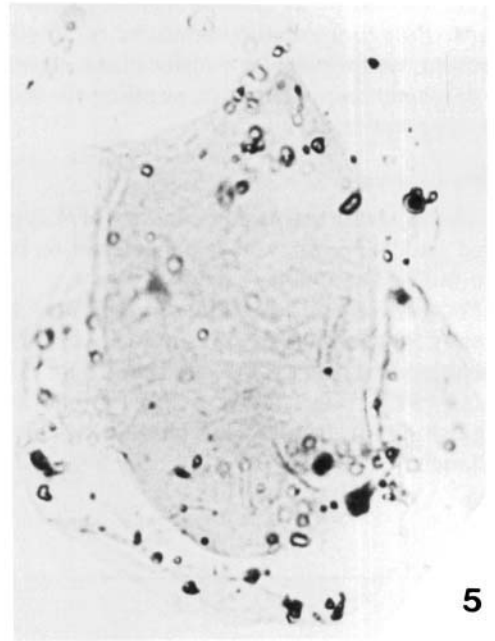
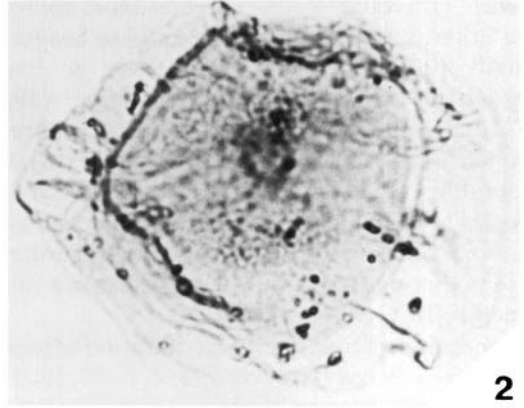
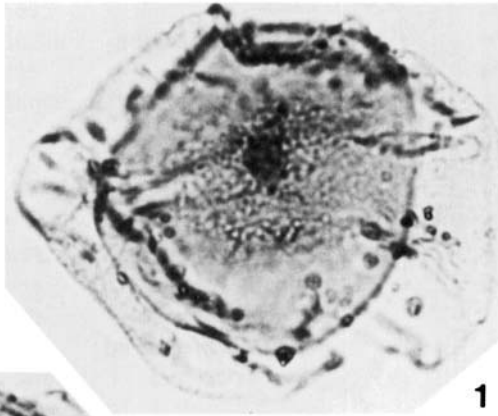
Figs. 1, 2. Slide IPEP/PVD/37/5 (122–124 m): fig. 1, dorsal surface; fig. 2, ventral surface, by transparency. (For details see Fig. 2b).

Figs. 3, 4. Slide IPEP/PVD/31/1 (108–110 m); specimen in lateral view: fig. 3, upper surface; fig. 4; lower surface, by transparency. Note position of cingulum and the perioperculum and endoperculum, both attached.

Fig. 5. Slide IPEP/PVD/25/4 (95–97 m); specimen in (?) slightly oblique dorsal view. (For details see Fig. 3b).

Fig. 6. Slide IPEP/PVD/25/4 (95–97 m); holotype in oblique lateral view. (For details see Fig. 1c).

Fig. 7. Slide IPEP/PVD/25/4 (95–96 m); specimen in (?) dorsal view. (For details see Fig. 3a).



material. For the moment its reassignment to the genus *Craspedodinium* Cookson & Eisenack, 1974, as *C. defloccata* (Davey & Verdier) seems most appropriate.

The other two species of *Hexagonifera* assigned provisionally to *Leberidocysta* by Stover & Evitt are *Hexagonifera laticaudata* Vozzhennikova (1967, p. 125–126, pl. 54, fig. 1) and *Hexagonifera scabrata* Jain & Taugourdeau-Lantz (1973, p. 64, figs. 11, 12). In view of poor illustrations and descriptions, which do not enable the determination of archaeopyle character, we are not in a position to suggest anything regarding their precise taxonomic identity; these species are therefore returned to *Hexagonifera*.

The species described by Burger, first as *Palaeostomocystis pergamentacea* (Burger, 1980a, p. 88, pl. 47, figs. 2, 3) and a little later as *?Leberidocysta pergamentacea* (Burger, 1980b, p. 272) is morphologically very dissimilar to *Polygonifera* and cannot be retained in it. For the present, we propose its transfer into *Craspedodinium* as *C. pergamentacea* (Burger), pending re-examination of the type material.

CONCLUSIONS

1) The separate taxonomic identity of *Polygonifera* is stressed and *Leberidocysta* is considered to be its subjective junior synonym.

2) *Polygonifera* and *Dingodinium* are two very different genera which exhibit similarity in characters of cyst cavation and general size and shape only (Mehrotra & Sarjeant, Ms). The table below summarises their distinguishing morphological characters, in order of importance.

<i>Polygonifera</i>	<i>Dingodinium</i>
(i) archaeopyle – apical	variable, intercalary or combination
(ii) apical horn – lacking	usually present and well developed
(iii) cingulum – generally weakly, less commonly well developed	usually well developed
(iv) periphragm very delicate in nature typically folded; fully, partially or not at all preserved	less delicate than in <i>Polygonifera</i> and generally well developed
(v) degree of pericoel development greatly affected by periphragm preservation and folding characters	pericoel development not significantly affected by periphragm preservation and folding
(vi) dorsoventral (usually slightly oblique) flattening more common than the lateral	lateral flattening most common

3) The complete and distinctive development of the cingulum in Oxfordian-Kimmeridgian species *P. evittii* and *P. staffinensis* (Kimmeridgian), its comparatively weak and less distinct representation in Aptian species *P. eisenackii*, and the lack of an indication of a cingulum in the Albian-Cenomanian species *P. chlamydata* seems to be of evolutionary significance. Further studies in this

Explanation of Plate 2

All figures are $\times 960$

Polygonifera eisenackii sp. nov.

Fig. 1. Slide IPEP/PVD/25/4 (95–97 m); paratype b in slightly oblique dorsal view. (For details see Fig. 2a).

Fig. 2. Slide IPEP/PVD/31/3 (108–110 m); specimen in (?) slightly oblique dorsal view. Note the attached operculum and subpolygonal periblast.

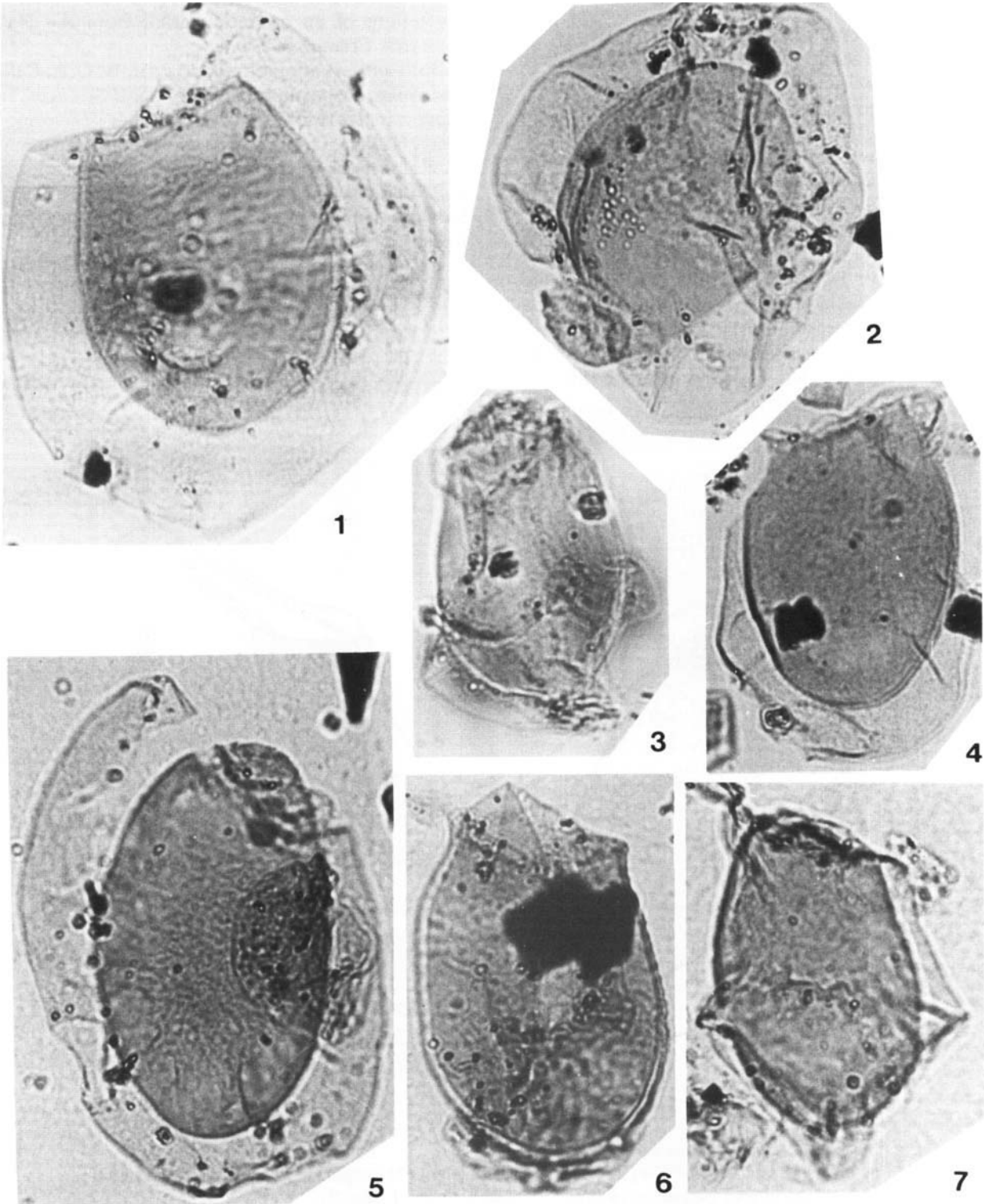
Fig. 3. Slide IPEP/PVD/31/4 (108–110 m); specimen in left lateral view. (For details see Fig. 1d).

Fig. 4. Slide IPEP/PVD/31/5 (108–110 m); paratype a in ventral view. (For details see Fig. 1a).

Fig. 5. Slide IPEP/PVD/25/4 (95–97 m); specimen in (?) oblique lateral view. (For details see Fig. 2c).

Fig. 6. Slide IPEP/PVD/31/5 (108–110 m); specimen in ventral view, showing a distinct apical archaeopyle and periphragm preserved only in the antapical region.

Fig. 7. Slide IPEP/PVD/31/4 (108–110 m); specimen in left lateral view. (For details see Fig. 1b).



direction are needed to elucidate this biological phenomenon.

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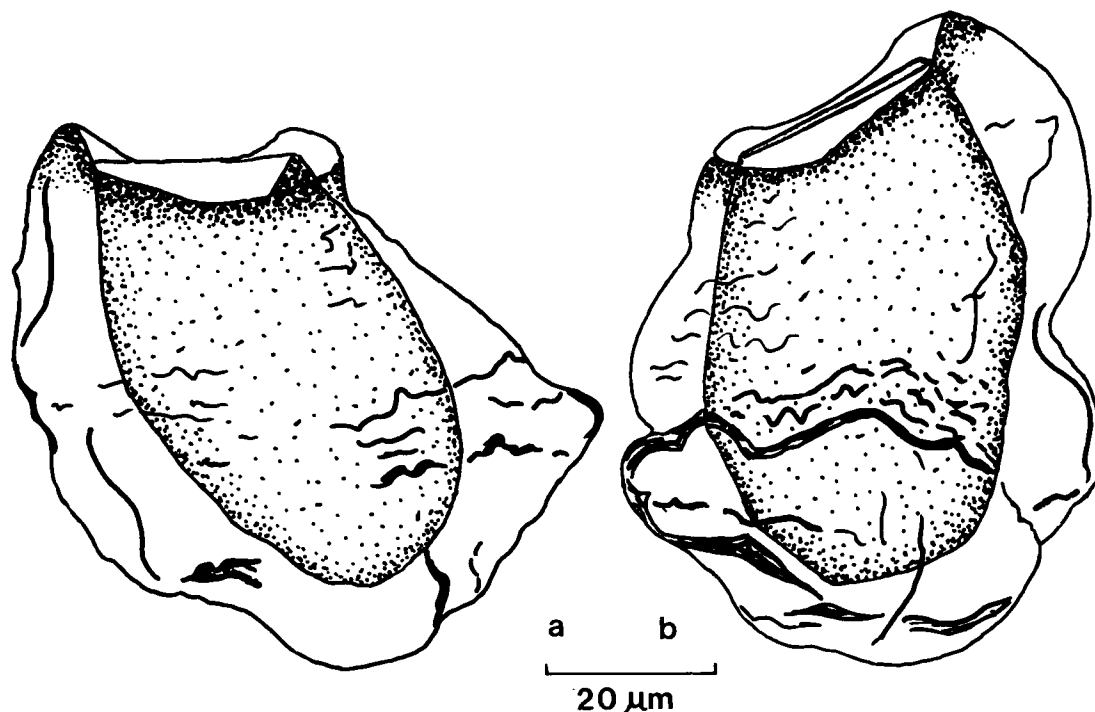


Fig. 3. *Polygonifera eisenackii* sp. nov.

- Slide IPEP/PVD/25/4 (95-97 m); specimen in (?) dorsal view, showing the peripyle, endopyle and cingulum distinctly. (See also Pl. 1, fig. 7).
- Slide IPEP/PVD/25/4 (95-97 m); specimen in (?) slightly oblique dorsal view. Note the distinct cingulum and the peripyle and endopyle. (See also Pl. 1, fig. 5).

[In all the figures, the shading is to clarify the character of archaeopyle and cyst cavation. It does not suggest cyst ornamentation].

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