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# Australian records of two lesser known genera of heterotrophic euglenids – *Chasmostoma* Massart, 1920 and *Jenningsia* Schaeffer, 1918

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**Summary**

We report on *Chasmostoma* and *Jenningsia*, two genera of heterotrophic euglenids which have not been reported subsequent to their initial descriptions. *Chasmostoma nieuportense* was poorly described from Belgian coastal waters by Massart in 1920. A redescription is offered on the basis of material observed in a prawn farm in Queensland, Australia. The genus is distinguished by having an anterior cavity into which the flagellum may be withdrawn when the organism is challenged. *Jenningsia* is a peranemid genus described with a single emergent flagellum by Shaeffer in 1918. The genus was later redescribed by Lackey in 1940 as *Peranemopsis*. The recent assumptions that these authors overlooked a second flagellum now seem to be in error, and we assign organisms previously described as *Peranema fusiforme* and *P. macrostoma*, species of *Peranema* described with one emergent flagellum, and species in the genus *Peranemopsis* to the genus *Jenningsia*.

**Key words**: Euglenida, Protozoa, *Chasmostoma nieuportense*, *Jenningsia diatomophaga*, *Jenningsia fusiforme* n. comb., *Jenningsia macrostoma* n. comb., *Jenningsia curvicauda* n. comb., *Jenningsia deflexum* n. comb., *Jenningsia furcatum* n. comb., *Jenningsia glabrum* n. comb., *Jenningsia granulifera* n. comb., *Jenningsia kupfferi* n. comb., *Jenningsia limax* n. comb., *Jenningsia macer* n. comb., *Jenningsia nigrum* n. comb., *Jenningsia sacculus* n. comb.

## Introduction

Heterotrophic flagellates may be significant meditators between the microbial communities and the metazoan food web in planktonic and benthic ecosystems. Despite their importance, their taxonomy has not been well studied. We comment here on three heterotrophic euglenids which may influence the population dynamics of other small flagellates and diatoms.

Massart (1920) figured a new and highly unusual euglenid, *Chasmostoma nieuportense*, from a coastal marsh in Belgium. He provided no verbal description. The taxon had a single long emergent flagellum, spiral markings and was clearly metabolic. The taxon resembles *Peranema* or *Heteronema* but the figures include no indication of an ingestion apparatus. The taxon is made distinctive by the presence of an anterior cavity into which the single emergent flagellum may be withdrawn. Although this is clearly a euglenid (*sensu* Simpson, 1997) and is not assignable to any other known genus, it has not been mentioned in any subsequent reviews of euglenids (Huber-Pestalozzi, 1955; Leedale, 1967; Larsen and Patterson, 1991). We have recently encountered this organism in a survey of protozoa in commercial prawn farms – ecosystems in which microbial communities play a significant role (Moriarty, 1997). We here use the opportunity to provide this taxon with a clearer identity.

The genus *Jenningsia* was created by Schaeffer (1918) for one species measuring 180 µm long, with one emergent flagellum, a large ingestion apparatus and a metabolic body with pellicular striations (Fig. 3a-b). The organism is clearly a euglenid with similarities to *Peranema*, a genus with two emergent flagella, the second one being tightly pressed to the body surface. A peranemid with a single emergent flagellum was later described by Lackey under the name *Peranemopsis* (Lackey, 1940). Patterson and Larsen (1991) suggested that *Jenningsia* and *Peranemopsis* were incompletely documented representatives of the genus *Peranema* by Patterson and Larsen (1991) and synonymised the genera. We here report on

observations which confirm the existence of peranemids with a single emergent flagellum and reinstate the genus *Jenningsia*.

### Material and Methods

*Chasmostoma nieuportense* were collected using slides placed in the water column of a commercial prawn-rearing pond at Seafarm Prawn Farm. The farm is a semi-intensive commercial *Penaeus monodon* farm abutting the Hinchinbrook Channel at Cardwell, Queensland, Australia.

*Jenningsia fusiforme* and *J. macrostoma* were collected from marine sediments at Botany Bay, Cape Tribulation (Queensland) and Quibray Bay, and from freshwater sediments at Albury, Cape Tribulation and Manly dam, Sydney in Australia. Sediments were seived and placed in trays. Lens tissues were placed on the surface of the sediments over which coverslips (No.1 22 x 22 mm) were laid. After 12 - 24 hours, those flagellates were collected on coverslips.

Living materials observed using Axiophot microscope (Zeiss) equipped with phographic facilities as described by Patterson (1982) and video facilities.

### Results

*Chasmostoma nieuportense* Massart, 1920. Figs 1a-c, 2

A highly metabolic gliding euglenid with a cell body measuring about 80 µm long when fully extended. With rounded cross-sectional profile of cell body. One flagellum arises within a reservoir, extends along a curving flagellar canal and then passes through a wide cavity which makes up most of the anterior apex of the cell. The cell contracts when jarred and the flagellum is quickly withdrawn into the cavity. After some seconds, the flagellum slowly starts to re-emerge, the proximal region emerging first and then drawing the distal part out subsequently. The cell also has an ingestion apparatus comprised of two short fine rods each with a swollen anterior end. The nucleus is located near the posterior end of the cell. The cell cytoplasm filled with granules of various sizes. The cell surface has fine spiral grooves. No extrusomes were observed nor was a contractile vacuole. Rare.

*Jenningsia fusiforme* (Larsen, 1987) Lee, Blackmore and Patterson, n. comb. Figs 3c, 4a-e.

The cell has an elongate aspect and has been reported with lengths from 25 to 45 µm. The body is anteriorly narrowed and posteriorly rounded, it has delicate pellicular striations following an S-helix. One flagellum emerges from the flagellar canal, is longer than the cell and beats mostly at anterior end. Two flagella are seen in the flagellar pocket which is located on the left hand side of the cell. The ingestion apparatus has two fine rods. A refractile cytoskeletal arc arises from the right rod, and curves towards the anterior of the cell. Optical sections through the anterior part of the cell (Figs 4a-c) show this as a short curving structure extending from near the front pole of the cell to near the anterior end of the ingestion rods. The nucleus is situated in the posterior of the cell. Cells move by gliding or squirming movements and are relatively common in both marine and freshwater sites.

This species has been reported under the name of *Peranema fusiforme* from marine sites at subtropical and tropical Australia, Brazil, Danish Wadden Sea, and Fiji (Larsen, 1987; Larsen and Patterson, 1990; Ekebom *et al.*, 1996; Patterson and Simpson, 1996; Lee and Patterson, 1999) and from freshwater sites in Australia (Schroeckh and Patterson, unpublished). Cells shown in Figs 4b-d and Fig. 4e were collected at freshwater site in Sydney and marine site in Botany Bay, NSW, Australia, respectively. *Peranema fusiforme* is usually described as having a short, curved recurrent flagellum which is tightly pressed to the cell surface (Larsen, 1987; Larsen and Patterson, 1990; Ekebom *et al*., 1996). Figure 4a was used by Larsen and Patterson (Larsen and Patterson, 1990; Fig. 24e) to indicate this character. In this figure, the recurrent flagellum was indicated by an arrow, but as is shown by Figs 4 b-d, this structure is an internal element of the cytoskeleton which attached to the right rod of the ingestion apparatus. As is shown in figure 4d, no recurrent flagellum emerges from the slit like opening of the flagellar pocket.

*Jenningsia macrostoma* (Ekebom *et al*., 1996) Lee, Blackmore and Patterson, n. comb. Figs 3d, 4 h-1.

This species has been reported with lengths from about 64 to 114 µm. The body is anteriorly narrowed and posteriorly rounded. It is very metabolic and has fine pellicular striations following a S-helix. The flagellar pocket is situated on the left ventral face of the cell. Two flagella are seen in the flagellar pocket, but only one flagellum emerges. The flagellum is slightly shorter than the cell and beats freely. The ingestion apparatus with two well-marked rods is strongly developed. A refractile cytoskeletal arc arises from the right rod and curves towards the anterior of the cell. Optical setcions through the anterior part of the cell show this as a short curving structure extending from near the front pole of the cell to near the anterior end of the ingestion rods. The nucleus is situated in the posterior part of the cell. Refractile granules are randomly distributed inside the cell. Rod-shaped muciferous bodies lie alongside pellicluar striations (Fig. 4k). Cells glide with a squirming movement. Less common than *J. fusiforme*.

This species has been described as *Peranema macrostoma* from marine sites at tropical and subtropical Australia, Brazil (Larsen and Patterson, 1990; Ekebom *et al*., 1996; Lee and Patterson, 1999). Cells of Fig. 4i and Figs 4j-l were collected at marine sites in Botany Bay, NSW

and Cape Tribulation, Queensland, Australia, respectively. Like *Peranema fusiforme*, it has been known that *P. macrostoma* has a short, curved recurrent flagellum which is tightly pressed to the cell surface (Ekebom *et al*., 1996). Figure 4h was taken from Ekebom *et al*. (1996; Fig. 4e). In this figure, the recurrent flagellum was indicated by an arrow, but the arrow indicates the curving element of the intracellular cytoskeleton. Only one flagellum emerges from the anterior opening canal as there is no recurrent flagellum emerging from the slit-like opening of the flagellar pocket (Fig. 4k).

## Discussion

*Chasmostoma nieuportense* was described originally from marine sites in Belgium (Massart, 1920). There is no verbal description of *Chasmostoma nieuportense*, but the description by Massart (1920) complies with Article 12 of the International Code of Zoological Nomenclature and is therefore available.

Despite the inadequacy of the original description (Massart, 1920), we can identify the organism observed at Cardwell with *Chasmostoma nieuportense*. The anterior cavity and unusual flagellar behaviour are taken to be distinctive. There is agreement in shape, the single emergent flagellum, cell surface markings, and metaboly. In the original description the organism is figured alongside *Diphylleia rotans* and, on the basis of the known size of this organism (Patterson and Zölffel, 1991; Brugerolle and Patterson 1990), we can estimate that the organism observed by Massart was about 50 µm long. This is consistent with the size of the organism observed by us. Because of the similarity of size we regard the species as being the same. Massart did not note the ingestion apparatus, but given the fineness of the rods it may have been overlooked. In his observations, the nucleus is located more anteriorly than in the Australian material, but we do not regard this as taxonomically significant.

This species is similar to few species of *Jenningsia*, *Peranema* and *Heteronema* in having a flexible body with pellicular striations and the genus is distinctive from all

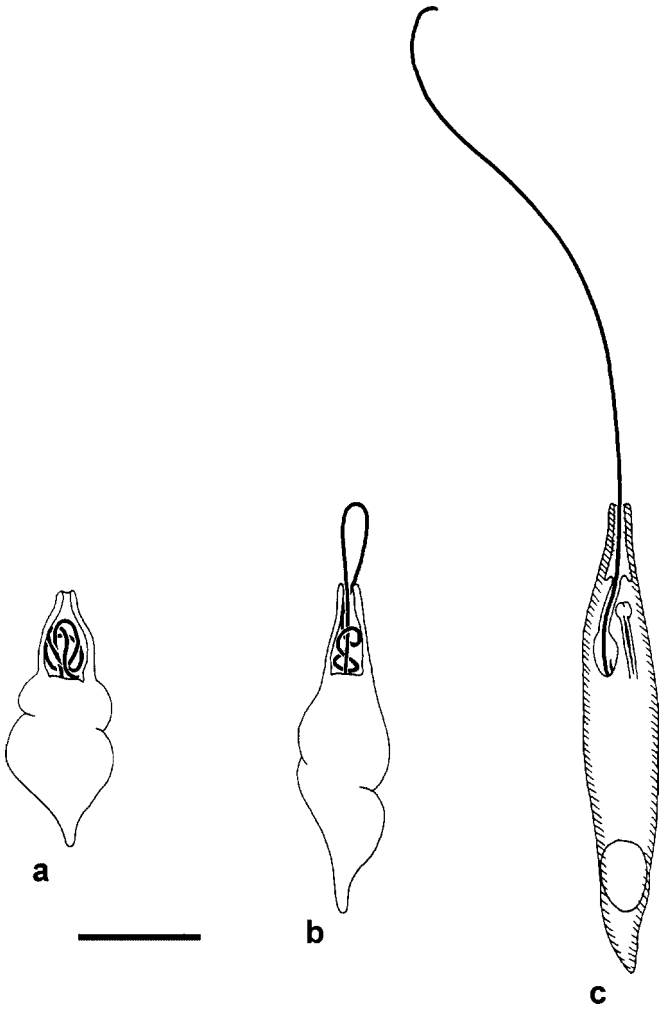


Fig. 1. Drawing of *Chasmostoma nieuportense*, (a) contracted cell with flagellum located within cavity, (b) relaxing cell with flagellum part extended, (c) gliding cell with extended flagellum. Scale bar represents 20 µm.

other genera of euglenids (Larsen and Patterson, 1991) because of the unique flagellar cavity. It is probably related to the other metabolic genera with ingestion devices and with a rounded cross-sectional profile and which are normally classified within the Heteronematales (i.e. *Heteronema*, *Peranema*, *Urceolus*). Despite its rarity (two observations in 75 years), the species clearly has a widespread distribution having been observed in Europe and Australia.

*Jenningsia* and *Peranemopsis* were created by Schaeffer (1918) and Lackey (1940) respectively to contain peranemid flagellates having one emergent flagellum and flexible body with pellicular striations. They are distinguished from the genus *Peranema* by having one

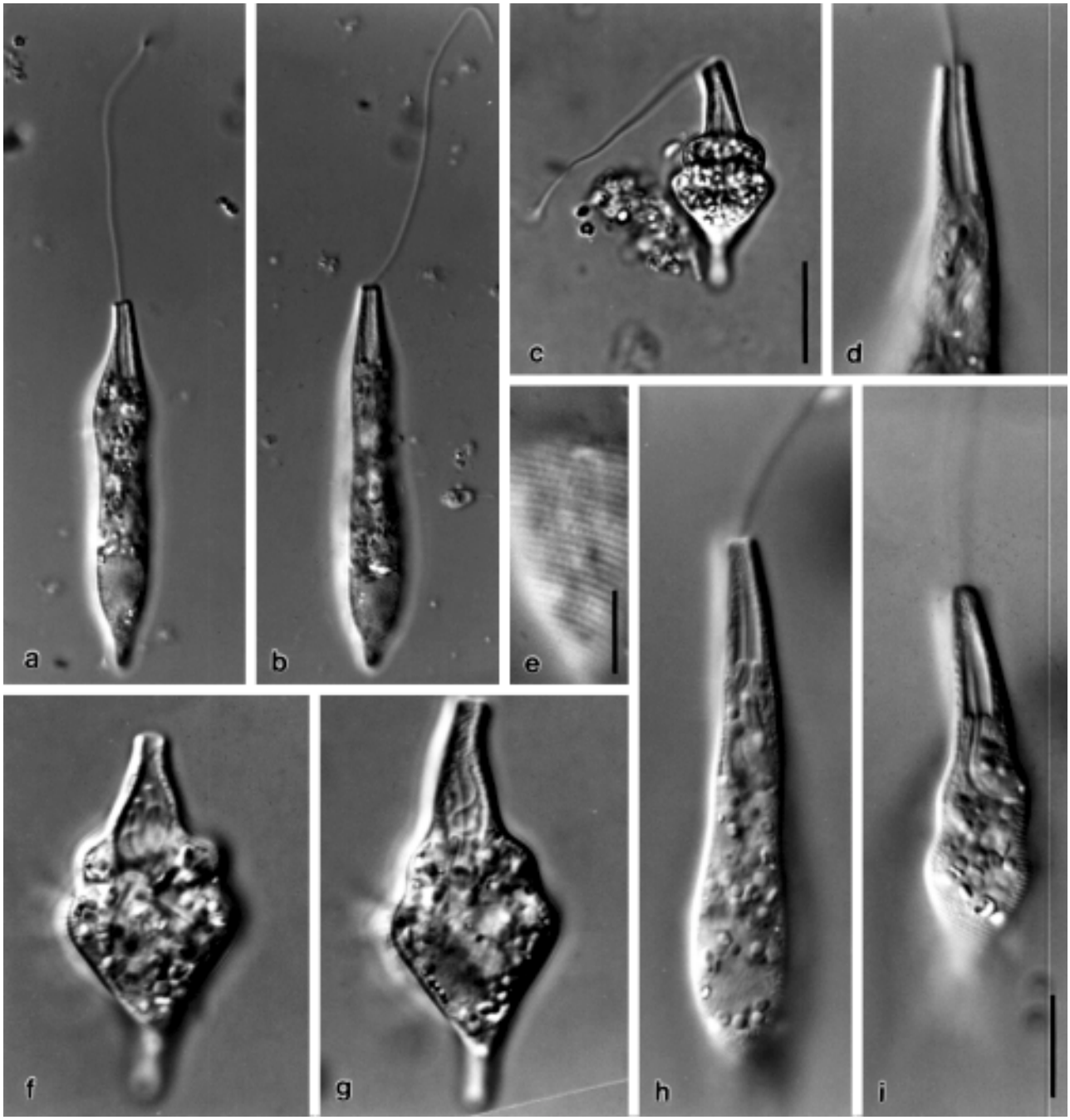


Fig. 2. *Chasmostoma nieuportense*. (a)-(b) gliding cells with extended anterior flagellum, and posterior nucleus, (c) contracted cell showing metaboly, (d) cavity located anterior to flagellar canal which can be seen as a narrow curving channel to the right of the cell, (e) cell surface showing ridges, (f) contracted cell with flagellum retracted into cavity, (g) relaxinf cell with flagellum re-extending from the cell, (h) gliding cell showing ingestion apparatus immediately behind the cavity, (i) illustration of flagellar canal curving away from the base of the cavity. Scale bars represent 20 μm in Fig. (c) for Figs (a)-(c), 5 μm in Fig. (e) and 10 μm in Fig. (i) for Figs (d)-(i).

flagellum, other species having a recurrent flagellum lying in a groove on the ventral face of the body (Fig. 4g).

*Peranema fusiforme* and *P. macrostoma* have been described with a short, curved recurrent flagellum which is tightly pressed to the cell surface (Larsen, 1987; Larsen and Patterson, 1990; Ekebom *et al*., 1996). Figure 4a of *Peranema fusiforme* was taken from Larsen and Patterson (Larsen and Patterson 1990; Fig. 24e) and figure 4h is of *Peranema macrostoma* and from Ekebom *et al*. (Ekebom *et al*., 1996; Fig. 4e), respectively. In these figures, the structure that was interpreted as the recurrent flagellum was indicated by arrows. Our present observations of both species indicate that the structure is a previously undescribed element of the cytoskeleton associated with the ingestion apparatus. As seen in figures 4d and 4k, only one flagellum emerges from the anterior opening canal (arrows).

We are therefore of the view that both of these species lack an emerging recurrent flagellum. As the genus *Jenningsia* was described and distinguished from *Peranema* on the basis of the absence of the second flagellum, we believe these two species are most appropriately transferred to that genus.

*Peranemopsis* was described by Lackey (Lackey, 1940) also as a peranemid with a single emergent flagellum. It was described without reference to *Jenningsia*.

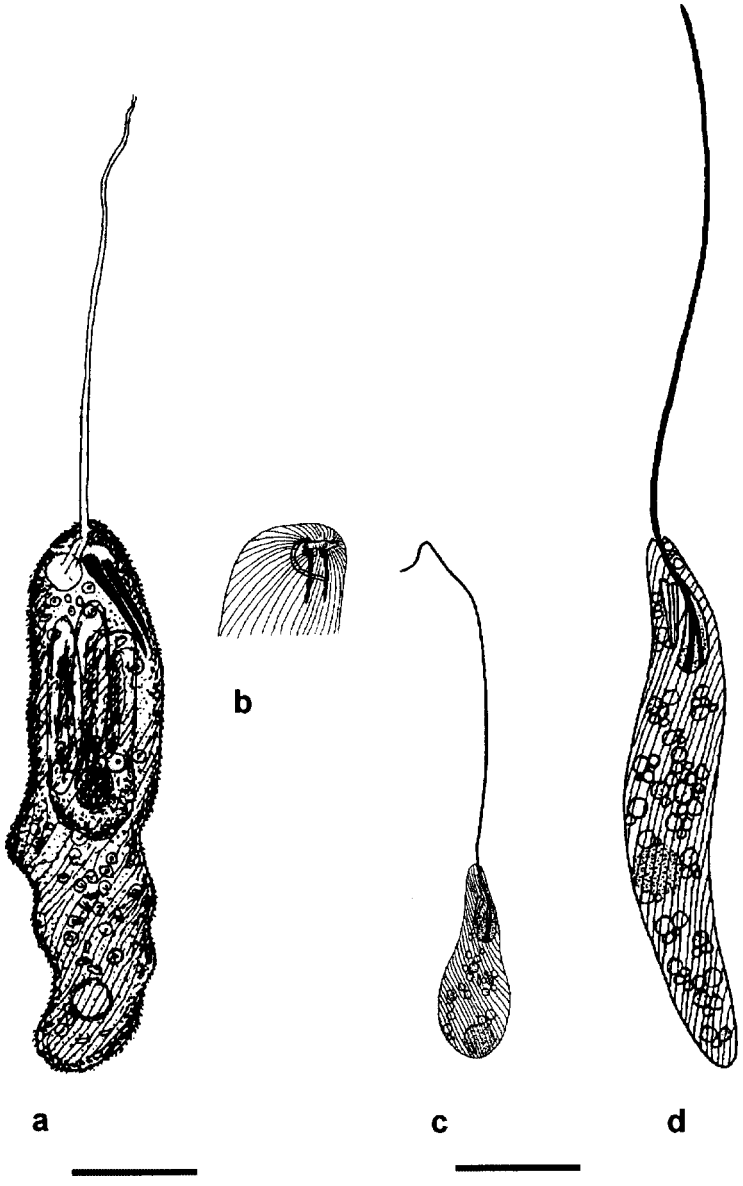


Fig. 3. Drawing of *Jenningsia diatomophaga, J. fusiforme,* and *J. macrostoma.* (a)-(b) *Jenningsia diatomophaga* redrawn from Scheffer (1918), (b) Anterior part of *J. diatomophaga* showing the intracellular cytoskeleton, (c) *Jenningsia fusiforme* after Lee and Patterson (1999), (d) *J. macrostoma* after Lee and Patterson (1999). Scale bars represents 40 μm in Fig. (a) for Figs (a)-(b) and 20 μm in Fig. (c) for Figs (c)-(d).

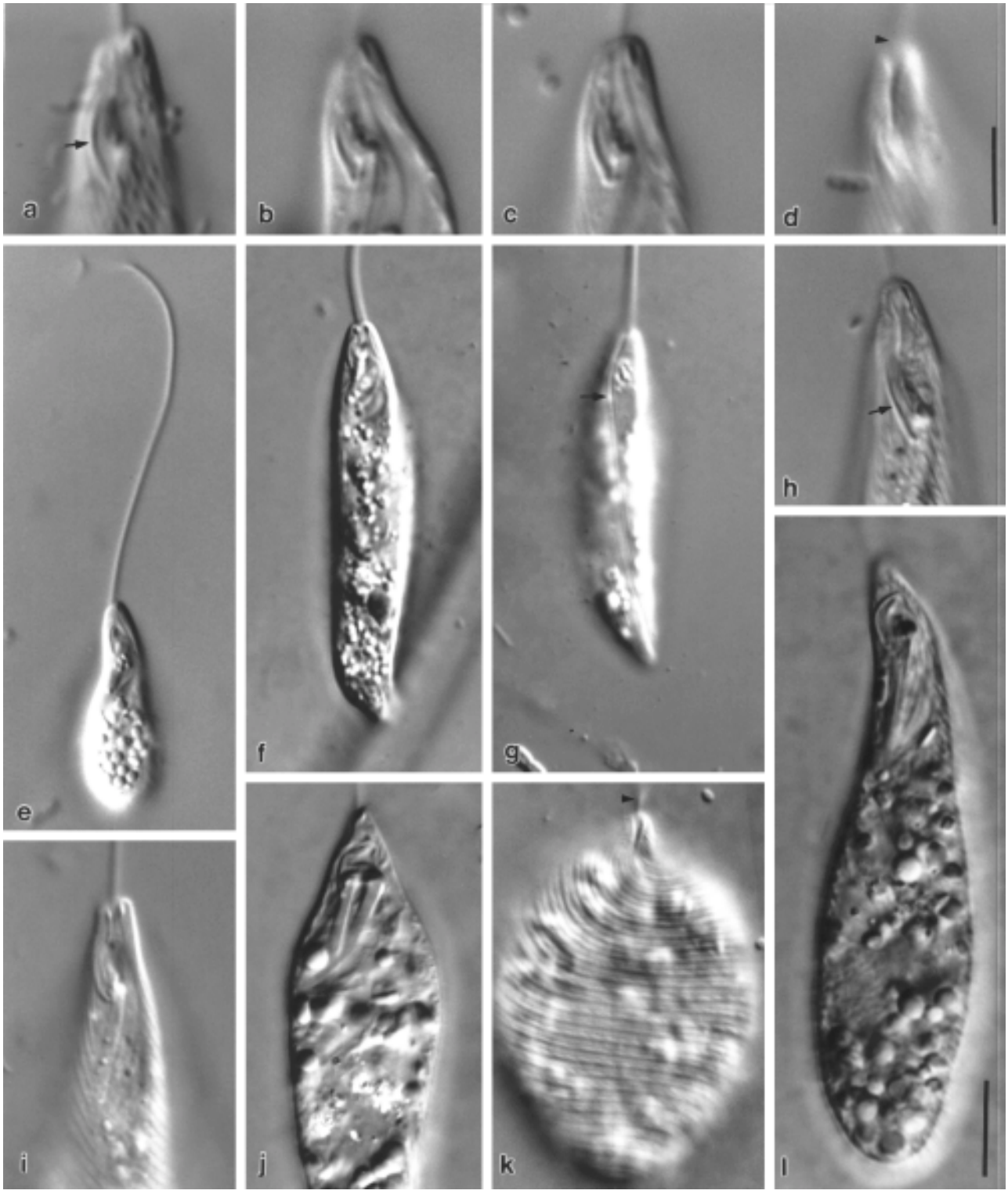


Fig. 4. *Jenningsia fusiforme* and *J. macrostoma*. (a)-(d) *Jenningsia fusiforme*, (a) micrograph used by Larsen and Patterson (Larsen and Patterson, 1990; Fig. 24e) and arrow shows show an element of the intracellular cytoskeleton, (b)-(d) all same cell, found at freshwater sites in Sydney, (e) overall shape of the cell found at marine site after Lee and Patterson (1999). (f)-(g) *Peranema inflexum*, (f) dorsal side showing the element of the intracellular cytoskeleton (arrow), (g) ventral side showing the recurrent flagellum in the groove (arrow), (h)-(l) *Jenningsia macrostoma*, (h) micrograph used by Ekebom *et al*. (Ekebom *et al*., 1996; Fig. 4e) and arrow shows an element of the intracellular cytoskeleton, (j)-(l) all same cell, found at marine sites in Australia. Arrowheads in Figs (d) and (k) show only one flagellum emerging from flagellar canal. Scale bars represent 10 μm in Fig. (d) for Figs (a)-(d) and 20 μm in Fig. (l) for Figs (e)-(l).

We regard *Peranemopsis* as a junior synonym of *Jenningsia.* Since *Peranemopsis striata* was created by Lackey in 1940, 11 species (*P. curvicauda, P. deflexum, P. furcatum, P. glabrum, P. granulifera, P. inflexum, P. kupfferi, P. limax, P. macer, P. nigrum, P. sacculus*) described in the genus *Peranema* but without reports of the recurrent flagellum have been transferred to the genus *Peranemopsis* by Larsen (1987) and Leedale (1967). One of these, *Peranemopsis inflexum* (Skuja, 1939) Leedale, 1967 has since been shown to have a recurrent flagellum in a ventral groove (Schroeckh and Pattertson, unpublished, Fig. 4f-g) and is therefore correctly referred to as *Peranema inflexum*. Until evidence is presented of the presence in them of a recurrent flagellum, the remainder should be transferred to the genus *Jenningsia.* On the basis of these considerations, we generate the new combinations *Jenningsia curvicauda, Jenningsia deflexum, Jenningsia furcatum, Jenningsia fusiforme, Jenningsia glabrum, Jenningsia granulifera, Jenningsia kupfferi, Jenningsia limax, Jenningsia macer, Jenningsia macrostoma, Jenningsia nigrum, and Jenningsia sacculus*. *Jenningsia macrostoma* is very similar to *Peranemopsis striata* in cell length and general appearance. In having a pointed posterior, *P. striata* differs from *J. macrostoma*. Although there are minor differences between two species, we do not regard statements about the shape of the posterior end with statements of variation as a good diagnostic character and so regard *P. striata* as a senior synonym *of J. macrostoma*. We therefore believe the genus *Jenningsia* contains 13 species, those listed above and *J. diatomophaga*.

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