S. Afr. J. Zool. 1996, 31(3) 145–153

A description of the life stages of *Echinoparyphium elegans* (Trematoda: Echinostomatidae)

P.H. King*
Department of Biology, Medical University of Southern Africa, P.O. Box 139, MEDUNSA, 0204 South Africa

J.G. van As
Department of Zoology & Entomology, University of the Free State, P.O. Box 339, Bloemfontein, 9300 South Africa

Received 18 August 1995; accepted 1 July 1996

The life cycle of *Echinoparyphium elegans* Looss 1899 is described from the Free State, South Africa.The freshwater snail *Bulinus tropicus* (Krauss 1848), the intermediate host of *Calicophoron microbothrium* (*Paramphistomum microbothrium* Fischoeder, 1901) in this area, serves as first intermediate host. The same snail species also harbours the metacercaria stage. Adults of this parasite were obtained by feeding infected snails to laboratory-reared rats. All stages of the life cycle were described by means of light and scanning electron microscopy. A natural infection was found in the cattle egret, *Bubulcus ibis* (Linnaeus 1758).

* To whom correspondence should be addressed

As part of an extensive study of snail-borne trematode parasites in the Free State, South Africa, freshwater snails were collected from an impoundment in the vicinity of Bloemfontein. *Bulinus tropicus*, the intermediate host of *Calicophoron microbothrium* (*Paramphistomum microbothrium* Fischoeder, 1901) in South Africa, was found to serve as first and second intermediate host for an echinostomatid parasite of the genus *Echinoparyphium* Dietz 1909. *Bulinus tropicus* naturally shedding 43-spined echinostome cercariae were only found during two surveys. Of all snails sampled only 10% were infected with metacercarial cysts in the pericardial sac. The life cycle of this parasite was experimentally completed and all stages described by means of light and scanning electron microscopy. The species belongs to the 43-spined *Echinoparyphium* group which is characterised by a collar spine arrangement of 5-5-3-3-27. A natural infection of six parasites was found in the duodenum of the cattle egret *Bubulcus ibis* collected from the same area. However, owing to insufficient material it was not possible to compare these trematodes with those raised in rodents as described in this manuscript. Because of its morphological similarity in all life stages, collar spine arrangement and use of the same host, this parasite is regarded as *Echinoparyphium elegans*, described by Looss (1899), Mouahid & Moné (1988), reported on by Lie & Umathevy (1965) in their comparison with *Echinoparyphium dunni* Lie & Umathevy 1965, and also by Lie, Heyneman, Jeyarasasingam, Mansour, Lee, Lee & Kostanian (1975) who described the life stages [as *Echinoparyphium ralphaudyi* Lie, Heyneman, Jeyarasasingam, Mansour, Lee, Lee & Kostanian 1975], Buscher (1978) in his discussion of the genus *Echinoparyphium* and by Kechemir (1980) who described the life stages [as *Echinoparyphium combesi* Kechemir, 1980]. The purpose of this paper is to report on the life cycle of *E. elegans* in South Africa by providing comprehensive taxonomic descriptions of all life stages and to supply information on the surface topography of the miracidium, cercaria and adult trematode.

Echinoparyphium elegans, being an echinostomatid parasite, may also be useful in the biological control of schistosomiasis. It is therefore essential to study this species also in South Africa.

Materials and methods

Thirty large specimens of *B. tropicus* were collected each month over a period of 12 months in an impoundment in the vicinity of Bloemfontein, Free State, South Africa. The prevalence of naturally infected snails shedding cercariae spontaneously was 0.5%, whereas the prevalence of naturally infected snails with metacercarial cysts was 10%. Snails were individually placed in separate containers in a well-lit room (fluorescent light and sunlight). Cercariae spontaneously shed were collected and prepared for light and scanning electron microscopy.

Rediae were obtained by crushing infected snails between two glass slides. Cercariae and miracidia were studied live by using egg albumen and heat to slow their movement. Neutral red and Nile blue sulphate were used as vital stains.

Metacercariae were obtained from the pericardial sac of the infected snails and studied while in the cysts or after manual removal from the cysts. Infected snails were fed to laboratory-reared Wistar rats. Adult parasites were collected from the duodenum of the rats using a dissecting microscope. The worms were flattened between two glass slides and fixed in hot AFA (Formol-acetic-alcohol) before staining with Borax carmine and Mayer's carmalum. Drawings were made by means of microscope projections from stained material.

Eggs were collected daily by sieving the faeces of infected rats through a helminth filter (Pitchford, Visser, Du Toit, De V. Pienaar & Young 1973). The eggs were incubated at a constant temperature of 28°C in petri dishes filled with distilled water.

Miracidia, cercariae, metacercariae and adult trematodes were fixed in 2.5% glutaraldehyde for scanning electron microscopy, washed in a phosphate buffer, dehydrated in a series of ethanols and critical-point dried. Sputter coating was done with gold and specimens were examined and photo-

graphed using an ISI 100 scanning electron microscope at 10 –20 kV. In all cases, 20 specimens of each life stage were measured and all measurements are in micrometres (μm). Minimum and maximum values are provided, followed in parentheses by the arithmetic mean and standard deviation.

Taxonomic description

Egg and miracidium (Figures 1a, b & 2a–d)

Infected snails with metacercarial cysts fed to Wistar rats produced eggs 14 days later in faeces. Eggs 91–105 (95 ± 3.8) × 52–63 (60 ± 3.3), light brown, with operculum at narrow end. Eggs incubated at 28°C hatched after 5 to 10 days.

Hatched miracidia very active for between 2 to 5 h. Miracidia 80–103 (95 ± 3.5) × 32–45 (38 ± 4.4) (Figure 2a). Four rows of epidermal plates (Figure 1a) present. First and second row each with 6 plates, 2 ventral, 2 dorsal and 2 lateral. Third row with 4 plates, 1 ventral, 1 dorsal and 2 lateral. Fourth row with 2 plates, 1 ventral and 1 dorsal (Figure 2b).

Plates in first row triangular 9–15 (12 ± 2.3) long × 8.8–10 (9.1 ± 0.4) broad at base. Plates in second row rectangular 13–23 (17 ± 4.2) × 9.9–10.6 (10.4 ± 0.4); plates in third row also rectangular 21–27 (24 ± 2.3) × 8.0–11 (9.6 ± 2.3). Plates in fourth row triangular 23–25 (24 ± 0.6) long × 12–17 (15 ± 3.3) broad at base. Cilia extending from plates 7.0–9.9 (8.2 ± 1.5) in length.

Two digitiform processes antero-laterally on both sides of body 2.4–5.2 (3.3 ± 0.8) long (Figure 2c). Apical gland filled with refractile granules posteriorly to apical papilla. Eyespots 3.2–3.8 (3.5 ± 0.3) in diameter, consist of lateral and posterior rod (Figure 2d). Lateral rod 2.9–4.1 (3.4 ± 0.5) long and posterior rod 2.9–3.5 (3.1 ± 0.3) long (Figure 1b). One flame cell present on either side of body. Flame cell on left side of body situated ventro-posteriorly, with excretory pore opening ventro-laterally. Flame cell on right side of body situated antero-dorsally, with excretory pore opening dorso-laterally. Both pores open between third and fourth epidermal plates. Germ cells and germ balls present in posterior third of body.

Sporocyst

Mother sporocysts develop near point of miracidial penetration, usually in mantle edge and head-foot region. Sporocysts were very small and difficult to separate from surrounding tissue.

Redia (Figures 1c–e)

Rediae of first generation, or mother rediae, colourless and give rise to daughter rediae. Mother redia (Figure 1c) 847–1022 (940 ± 75.8) × 147–203 (169 ± 30.5). Collar continuous, measures 180–208 (192 ± 14.1) across and situated 168–171 (169 ± 1.9) from anterior end of body.

Well-developed pharynx 85–119 (98 ± 19.0) × 84–125 (98 ± 23.4) situated at anterior end of body. Pharynx followed by short gut, 134–146 (141 ± 6.4) × 42–50 (46 ± 4.2). Posterior locomotor appendages situated 608–797 (713 ± 96.5) from anterior end of body.

Mother redia gives rise to daughter rediae. Up to 12 daughter rediae observed in single mother redial body (Figure 1c). Daughter rediae 102–132 (115 ± 14.6) × 36–40 (38 ± 2.1). Pharynx 23–26 (25 ± 1.2) × 23–28 (26 ± 2.2) at anterior end of body.

Released daughter rediae not yet producing cercariae measure 548–610 (565 ± 25.5) × 114–130 (121 ± 7.1). Collar situated 65–88 (76 ± 10.7) from anterior end of redial body, is not conspicuous and measures 119–143 (136 ± 12.2) across. Pharynx 52–68 (57 ± 6.9) × 52–68 (58 ± 6.3) at anterior end of body, followed by short gut 107–143 (137 ± 16.5) × 32–38 (36 ± 1.9). Posterior locomotor appendages situated 326–382 (358 ± 24.9) from anterior end of body.

Daughter rediae located predominantly in ovotestis and digestive gland of snail host. Rediae can be divided into two distinct groups on size. First group short and contains on average only two cercariae within redial sac. Rediae (Figure 1d) 730–937 (862 ± 83.4) × 154–201 (173 ± 17.6). Collar conspicuous and located 60–85 (75 ± 8.7) from anterior end of body, measuring 126–157 (131 ± 12.6) across. Pharynx 46–55 (52 ± 3.1) × 46–52 (51 ± 2.9) followed by gut 68–93 (78 ± 7.9) × 42–49 (44 ± 2.8). Posterior locomotor appendages located 435–708 (559 ± 96.2) from anterior end of body.

Second group of daughter rediae much larger with more cercariae than first group. Present group with between 6 to 9 cercariae in redial sac. Rediae (Figure 1e) 1226–1560 (1411 ± 96.5) × 174–214 (203 ± 13.8). Collar more conspicuous, measuring 141–205 (165 ± 24.0) across and located 76–174 (112 ± 39.1) posteriorly to anterior end of body. Pharynx 65–81 (68 ± 7.7) in diameter, and followed by short gut 76–108 (87 ± 10.8) × 43–49 (46 ± 2.7). Posterior locomotor appendages located 935–1187 (1015 ± 88.2) from anterior end of body.

Cercaria (Figures 1f–g; 2e–f & 3a–f)

Body oval (Figure 1f) 220–276 (247 ± 20.7) × 112–156 (138 ± 15.6). Collar with its characteristic 43 spines distinct, measuring 58–99 (77 ± 16.4) across (Figure 2e). Arrangement of spines (Figure 1g) as follows: five corner spines on each side (Figure 2f), three lateral spines in single row and 27 dorsal spines in two rows, alternating 14 oral and 13 aboral spines. Spine measurements as follow: corner spines 5.3–9 (5.6 ± 0.3) × 0.9–1.1 (1.06 ± 8.9); lateral spines 6.1–6.3 (6.2 ± 0.1) × 0.9–1.1 (1.0 ± 0.1); aboral dorsal spines 5.5–6.1 (5.7 ± 0.3) × 0.9–1.1 (1.0 ± 0.1) and oral dorsal spines 5.2–5.5 (5.4 ± 0.2) × 0.9–1.1 (1.0 ± 0.1). All collar spines retractable (Figure 2e).

Oral sucker 37–43 (40 ± 2.6) × 38–45 (42 ± 2.6), ventro-subterminally and less differentiated than acetabulum (Figures 2e & 3b). Oral sucker with many sensory receptors (Figure 3a), characterised by long and short cilia. Prepharyngeal sac 6.2–7.8 (6.8 ± 0.8) × 7.8–14.2 (11.4 ± 2.8) situated posteriorly to oral sucker. Sac contains two large granules, measuring 4.2–5.2 (4.5 ± 0.4) in diameter. Sac followed by short prepharynx, 19–23 (21 ± 1.5) × 2.1–4.2 (3.3 ± 1.1) and pharynx 17–23 (20 ± 2.6) × 15–20 (19 ± 2.7). Oesophagus 54–76 (65 ± 9.7) × 5.2–6.2 (5.7 ± 0.5), bifurcates preacetabularly into two intestinal caeca, extending almost to posterior end of body (Figure 1f).

Acetabulum (Figure 3b) situated 97–144 (109 ± 13.9) posteriorly to oesophagus in posterior third of body. Acetabulum 37–44 (42 ± 3.8) × 40–49 (47 ± 3.6), distinct, protrusible, and round to oval. Few sensory receptors present on and around sucker (Figure 3b). Body of cercaria filled with many cystogenous cells, 5.3–7.9 (6.5 ± 0.8) × 3.3–5.3 (4.1 ± 0.7). Cells

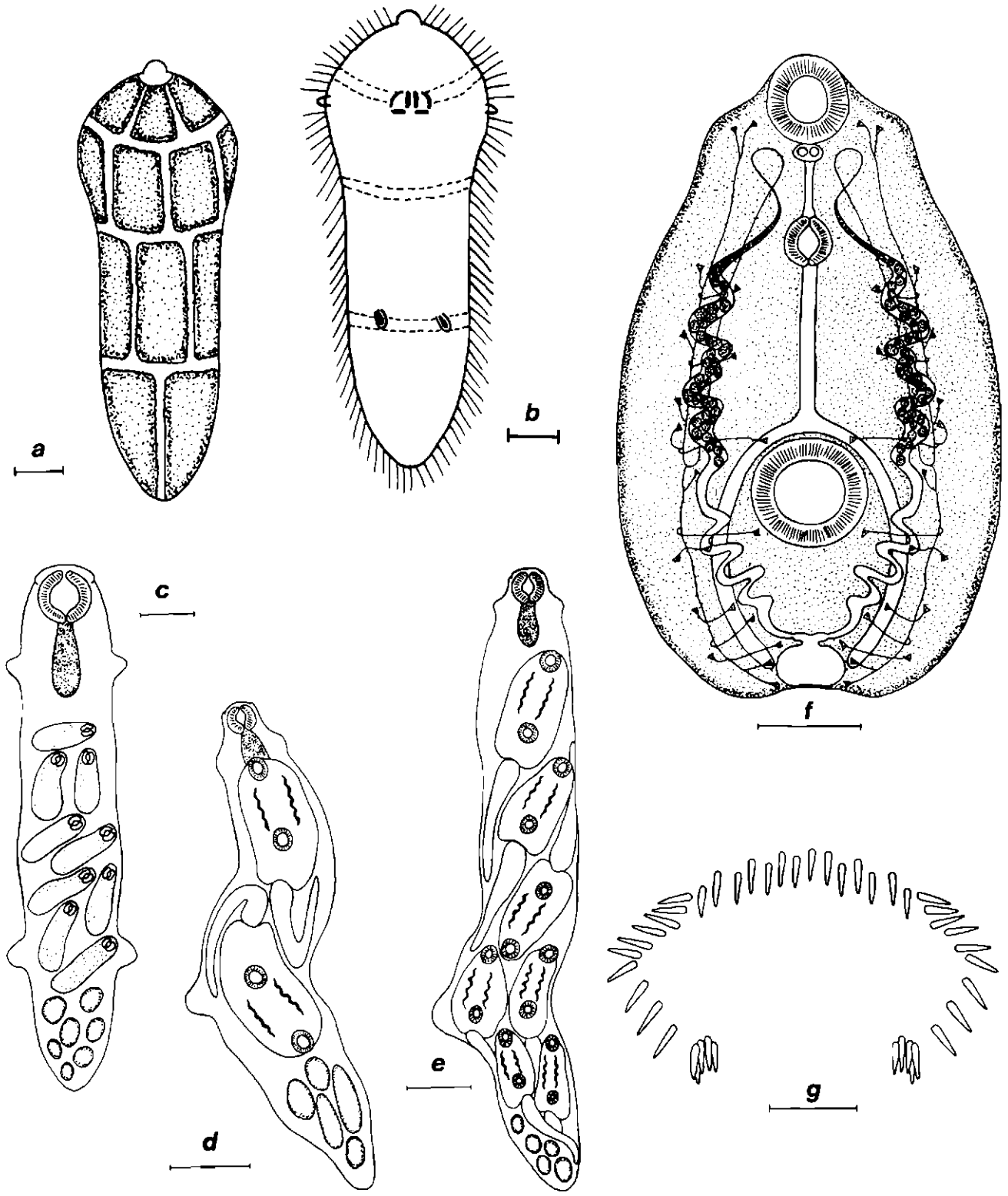

Figure 1 a–g Microscopic projection drawings of stages of the life cycle of *Echinoparyphium elegans*. (a) Miracidium showing four rows of epidermal plates. (b) Miracidium morphology showing two flame cell openings between third and fourth epidermal plates. (c) Mother redia, with redia of second generation. (d) Small daughter redia with only two cercariae. (e) Large daughter redia with cercariae. (f) Cercarial morphology showing the excretory system. (g) Arrangement of cercarial collar spines. Scale bars: a, 40 µm; b, 14 µm; c, d, & e, 10 µm; f, 130 µm and g, 145 µm.

dark pigmented and situated predominantly in posterior half of body. Cercaria bears single tail 410–501 (455 ± 34.1) × 54–76 (62 ± 7.6). Finfolds absent.

Excretory system stenostomate (Figure 1f). Main excretory duct on either side of body extends anteriorly from anterior part of excretory bladder, to posterior of acetabulum. Duct dilates between acetabulum and pharynx and is filled with refractile granules, measuring 5.2–6.5 (6.0 ± 0.6) in diameter. Anterior of pharynx duct turns back upon itself till level of acetabulum, where it divides into smaller anterior and poste-

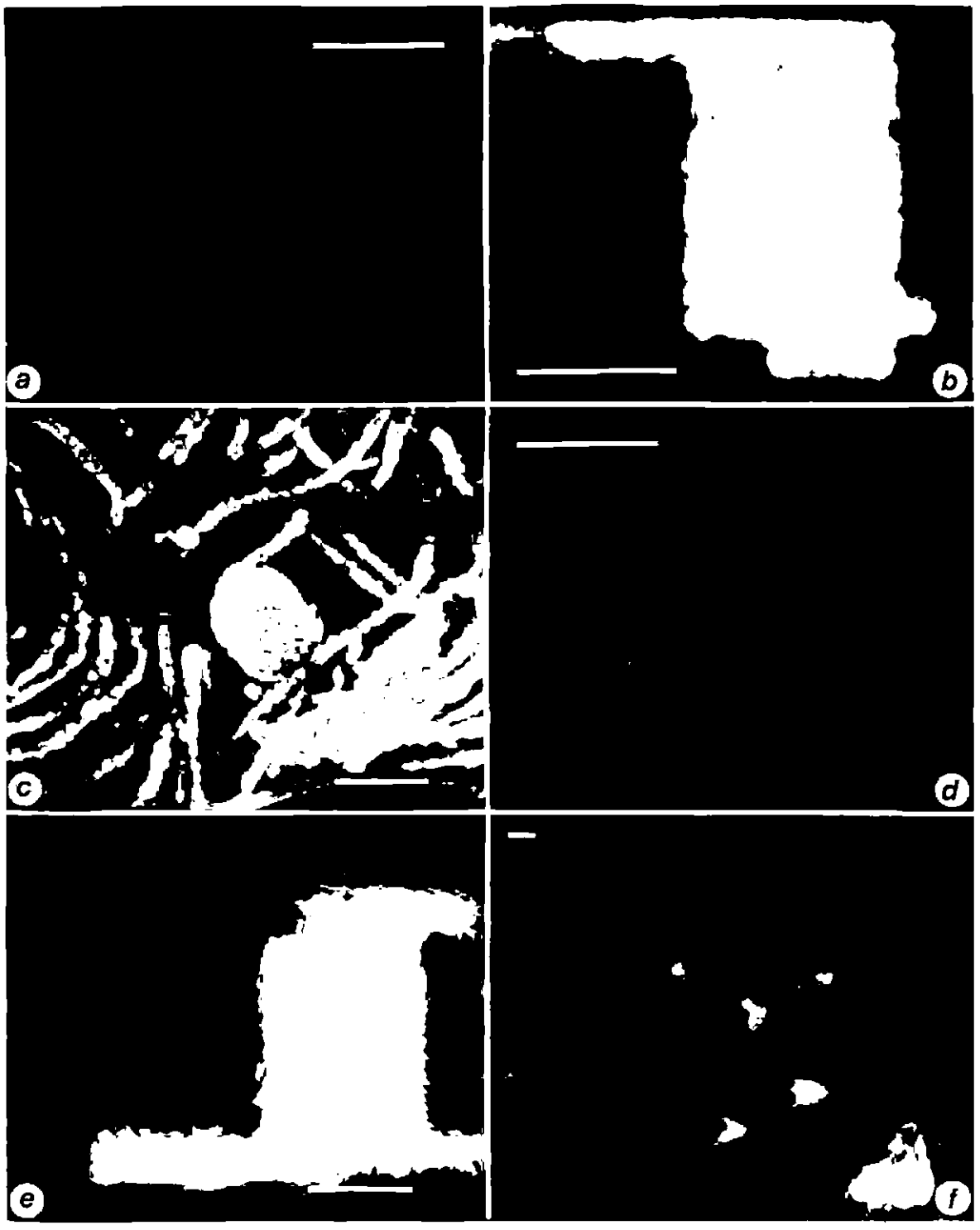

Figure 2 a,b,d Light micrographs of the miracidium of *Echinoparyphium elegans*. (a) Miracidium morphology. (b) Miracidium showing arrangement of epidermal plates. (d) Anterior view of miracidium to show morphology of eyespots. **c,e,f** Scanning electron micrographs of the miracidium and cercaria of *E. elegans*. (c) Lateral process of miracidium. (e) Collar spines around oral sucker of cercaria. (f) Protruding corner spines of cercarial collar spines. Scale bars: a, 25 μm; b & d, 20 μm; c & f, 1 μm and e, 10 μm.

rior excretory ducts. Flame cells difficult to detect. Nine flame cell pairs anteriorly and 11 flame cell pairs posteriorly to acetabulum observed.

Body surface of cercariae shows an uneven tegument with numerous minute spines protruding from it (Figure 3c). Spines extend from just behind collar to level of acetabulum. Various sensory receptors observed on both body and tail. Receptors predominantly on anterior part of body around oral sucker (Figure 3a). Two types of uniciliated papillae observed: short uniciliated papillae concentrated on oral sucker (Figure 3a) and posterior to oral sucker (Figure 3e), and long papillae concentrated around posterior part of oral sucker (Figure 3d). Similar long uniciliated receptors also present in central area of tail stem (Figure 3f). Short uniciliated receptors and receptors without cilia present on acetabulum (Figure 3b).

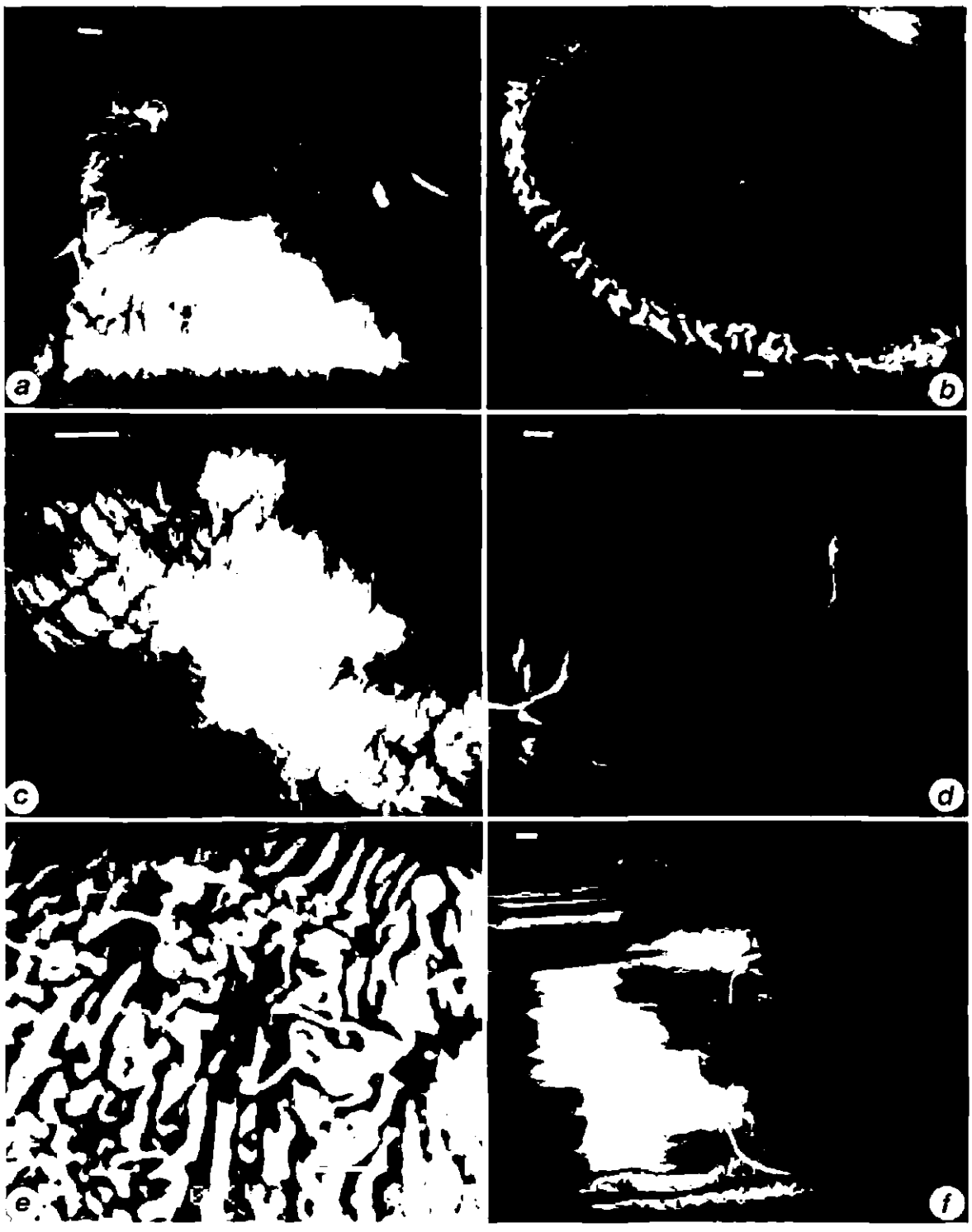

Figure 3 a–f Scanning electron micrographs of the cercariae of *Echinoparyphium elegans*. (a) Oral sucker with sensory receptors. (b) Acetabulum, also with sensory receptors. (c) Ventral tegument of body. (d) Long uniciliated papillae around oral sucker. (e) Short uniciliated papillae posterior to oral sucker. (f) Uniciliated papillae on tail stem. Scale bars: a, b, d, & f, 1 μm and c & e, 12 μm.

Metacercaria

Metacercariae found in cysts in pericardial sac of *B. tropicus*. Number of cysts varied between 5 to 20 per snail. Metacercarial cysts 169–183 (177 ± 6.8) × 176–183 (180 ± 3.6), with cyst wall 1.4–2.9 (1.9 ± 0.7) thick. Metacercariae manually excysted oval to elongate and 560–824 (679 ± 99.1) × 151–212 (181 ± 30.4). Collar with spines well developed, measuring 118–160 (130 ± 21.5) across. Spine arrangement as follows: five corner spines on both sides of pharynx, three oral and two aboral; three lateral spines in single row; 27 dorsal spines in double row, alternating 14 oral and 13 aboral spines. Spine measurements as follow: corner spines 16–22 (19 ± 2.5) × 2.9–4.4 (3.6 ± 0.7); lateral spines 12–16 (14 ± 1.8) × 2.9–4.4 (3.4 ± 0.7); aboral dorsal spines 13–17 (15 ± 2.2) × 2.9–4.4 (3.2 ± 0.4); and oral dorsal spines 10–13 (11 ± 1.1) × 2.2–2.9 (2.5 ± 0.4).

Oral sucker terminally situated, 42–68 (57 ± 13.1) × 53–75 (63 ± 11.1). Prepharynx 21–51 (35 ± 15.1) long continues

into pharynx 21–35 (27 ± 6.9) × 16–30 (23 ± 6.9). Oesophagus bifurcates in forebody into two intestinal caeca, which extend to posterior end of body. Acetabulum 56–103 (80 ± 23.4) × 61–89 (76 ± 14.1), situated in posterior half of body.

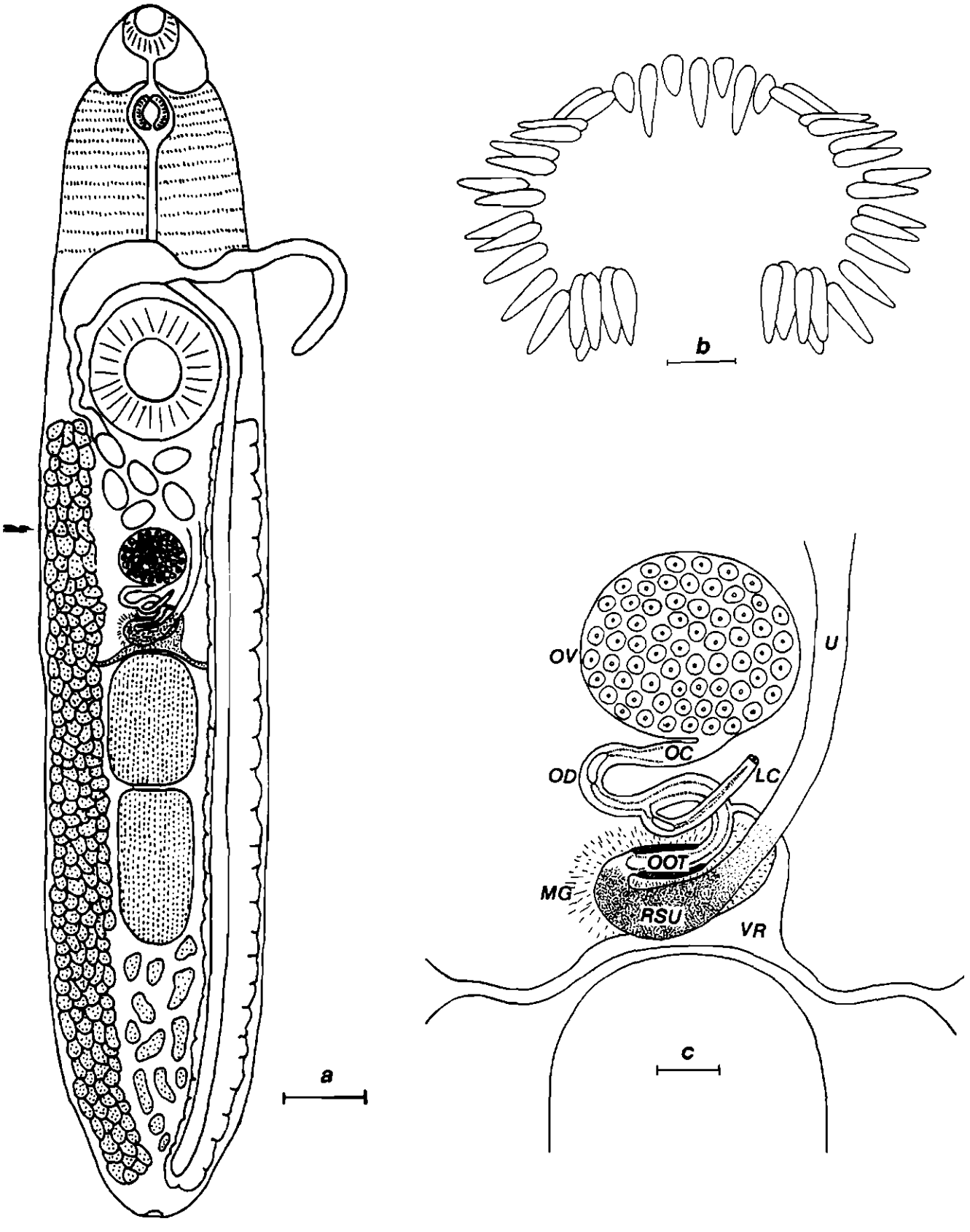

Figure 4 a–c Microscopic projection drawings of the adult of *Echinoparyphium elegans*. (a) Morphology of the adult trematode. (b) Arrangement of collar spines around oral sucker. (c) Female reproductive system of adult trematode. Scale bars: a, 160 µm and b & c, 40 µm. LC, Laurer's canal; MG, Mehlis's gland; OV, ovary; OC, ovicapt; OD, oviduct; OOT, ootype, RSU, uterine seminal receptacle; U, uterus; VR, vitelline reservoir.

Body covered by numerous minute spines, predominantly anteriorly. These spines gradually decrease in number and size posteriorly.

Adult (Figures 4a–c & 5a–f)

Echinoparyphium elegans Looss, 1899

Three weeks after infecting rats with infected snails, adult trematodes were found in duodenum of experimental hosts. Body elongated (Figure 4a), 2223–2676 (2424 ± 136.8) × 302–463 (387 ± 46.6). Collar with its 43 well-developed spines measures 181–287 (224 ± 31.7) across. Spine arrangement (Figure 4b) as follows: five corner spines, three oral and two aboral, on each side; three lateral spines in single row; followed by 27 dorsal spines in two rows, alternating 14 oral

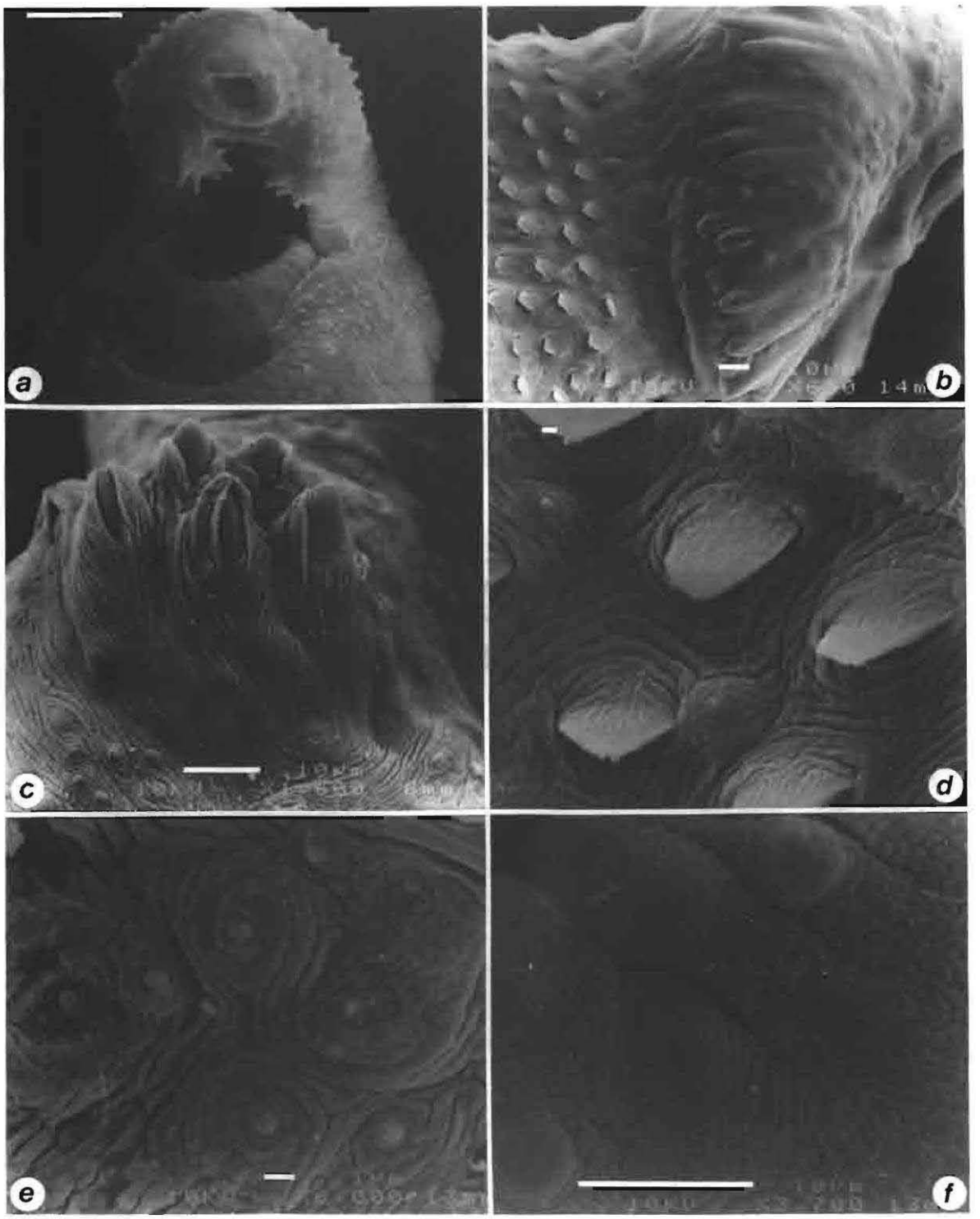

Figure 5 a–f Scanning electron micrographs of the adult of *Echinoparyphium elegans*. (a) Anterior end of trematode, showing oral sucker, collar with spines and acetabulum. (b) Collar with dorsal spines, some retracted and others extended from tegumental pockets. (c) Corner spines, also retractable. (d) Body scales with small sensory receptors in between. (e) Sensory papillae with short cilia between spines on collar. (f) Sensory receptors without cilia around oral sucker. Scale bars: a, 100 µm; b, c & f, 10 µm and d & e, 1 µm.

and 13 aboral spines. Spine measurements as follow: corner spines, 42–52 (45 ± 2.6) × 12–15 (13 ± 1.1) with shortest corner spines usually latero-oral spines, 41–46 (43 ± 1.3) × 9.8–12 (10.5 ± 0.8); lateral spines shorter than corner spines, 38–45 (40 ± 3.7) × 7.4–11 (8.7 ± 0.9); dorsal spines 37–47 (42 ± 3.4) × 10–13 (12 ± 1.2), except for the 4 to 6 most oral dorsal spines which measure 18–29 (24 ± 3.9) × 5.9–8.9 (7.6 ± 1.3). Collar spines housed in elevated areas on collar (Figures 5b & c). They appear to be retractable (in Figure 5b some spines are extended and some are retracted). Corner spines grouped together, extending from elevated areas (Figure 5c).

Body not covered by sharp spines. Anterior region of body covered with modified scale-like tegumentary spines, which decrease posteriorly in number, size and density (Figure 5b). Scales cover only 1/6 of body dorsally and ventrally, and 1/5 of body laterally. Scale-like spines triangular with even smooth edges (Figure 5d).

Oral sucker subterminal (Figure 5a), 90–121 (107 ± 10.0) × 92–151 (114 ± 19.7). Prepharynx 15–80 (49 ± 14.8) long continues into pharynx 75–151 (109 ± 22.3) × 73–96 (83 ± 7.4). Oesophagus 283–352 (311 ± 29.1) × 29–36 (33 ± 2.8), bifurcates in forebody into two intestinal caeca, which extend to almost posterior end of body. Acetabulum 227–332 (298 ± 35.9) × 196–317 (267 ± 32.8), larger than oral sucker, and situated in anterior third of body (Figure 5a).

Reproductive system situated in middle of body (Figure 4a). Testes tandem, smooth, and situated in posterior half of body. Anterior testis 312–323 (265 ± 43.7) × 136–226 (177 ± 20.8), and posterior testis 227–327 (294 ± 38.3) × 121–275 (170 ± 47.2). Cirrus sac 272–400 (328 ± 37.1) × 88–105 (100 ± 6.9), lies anteriorly to acetabulum, or sometimes halfway down acetabulum. Sac contains single seminal vesicle, pars prostatica and aspinous cirrus. Protruded cirrus 345–532 (452 ± 64.3) × 41–51 (47 ± 3.9). Genital pore situated directly anterior to acetabulum.

Ovary in midbody oval, 88–165 (125 ± 21.5) × 121–187 (146 ± 27.9). Ootype complex situated between ovary and anterior testis (Figure 4c), with ciliated ovicapt, 51–59 (55 ± 3.2) × 10–18 (13 ± 3.6), extending into ciliated oviduct, measuring 73–102 (87 ± 11.8) long. Laurer's canal 73–90 (84 ± 7.5) × 8.0–10 (8.8 ± 0.8), opens onto dorsal surface of body. Vitelline reservoir elongated 61–73 (69 ± 5.3) × 11–17 (15 ± 2.6). No seminal receptacle. Uterine seminal receptacle 70–96 (83 ± 10.5) × 15–50 (28 ± 16.7), often filled with sperm. Mehlis's gland diffuse. Uterus situated anteriorly to anterior testis, intercaecal, and contains 15 to 22 eggs and is connected with genital pore through metraterm. Eggs in uterus measure 84–92 (87 ± 3.4) × 48–59 (54 ± 4.6).

Vitellaria in lateral fields extend from midway between acetabulum and ovary, to posterior end of trematode body, partly overlapping intestinal caeca and concentrated in posterior third of body. Excretory vesicle saccular posteriorly, and opens at posterior end of body.

Sensory papillae with cilia (Figure 5e), concentrated in anterior part of body. Papillae on collar and between body scales very small, with short cilia (Figures 5d & e). Sensory papillae on posterior part of body without cilia (Figure 5f).

Taxonomic summary

Experimental host: *Rattus norvegicus*. Wistar strain.

Natural host: *Bubulcus ibis* (Linnaeus, 1758), the cattle egret.

Type locality: Bloemfontein and surrounding water bodies, Free State, RSA.

Site of infection: Duodenum.

Specimens deposited: Voucher specimens: No. 90/01/19–2, 90/06/26-1 in the National Museum, Bloemfontein, South Africa.

Discussion

The genus *Echinoparyphium* is represented by species characterised by a well developed head collar with a double dorsally uninterrupted row of spines. Buscher (1978) provided a modified version of the generic diagnosis of this group given earlier by Yamaguti (1958). Species are very cosmopolitan in their distribution and include parasites of which the number and arrangement of collar spines vary greatly from each other.

In a review of the genus, Buscher (1978) retained 25 species, including six species with 43 collar spines. Revisions by Bychovskaja-Pavlovskaja (1978) and Mouahid & Moné (1988) reduced the number of species to only two viz. *E. elegans* and *E. dunni*, having 43 spines and a collar spine arrangement of 5-5-3-3-27. Minor morphological dissimilarities between *E. elegans* and *E. dunni* were pointed out by Mouahid & Moné (1988) and Lie *et al.* (1975) [as *E. ralphaudyi*]. The main differences between these two species are the intermediate snail hosts and the experimental final hosts. In the case of *E. elegans*, the snail host is *Bulinus truncatus* (Audouin 1827) (see Mouahid & Moné 1988), while *Lymnaea rubiginosa* (Michelin) is the snail host for *E. dunni* (see Lie & Umathevy 1965). *Echinoparyphium elegans* has been reared experimentally in canaries, chickens, pigeons and rats (Mouahid & Moné 1988), while *E. dunni* would not develop to maturity in rodents (Lie & Umathevy 1965)

The life stages of the present study compare favourably with those of *E. elegans* presented by Mouahid & Moné (1988) and *E. ralphaudyi* described by Lie *et al.* (1975). However, they differ morphologically in the following respects:

(1) The adult trematode is smaller than both previously mentioned parasites.

(2) The eggs are smaller than the eggs of *E. ralphaudyi*, but compare well with *E. elegans*.

(3) The number of eggs in the uterus varies between 15 to 22 which is less than described for both *E. elegans* and *E. ralphaudyi*.

(4) The mother redia is smaller than that of *E. ralphaudyi* and the daughter rediae are smaller than both *E. elegans* and *E. ralphaudyi*.

(5) The cercaria is smaller than the cercariae described for *E. elegans* and *E. ralphaudyi*.

In an unpublished report on larval echinostome flukes from southern Africa, Taplin (1964) described an echinostome cercaria which she named *Cercaria montgomeriana*, with the redia and metacercarial cyst stages, but no adult stage. These cercariae and metacercariae have a collar bearing 54 spines arranged in a single row. This cercaria was shed by *B. tropicus* and *Bulinus forskali* (Ehrenberg 1831). Appleton, Donnelly & Eriksson (1983) described an adult echinostome bearing a collar with 43 spines which was recovered from

experimentally infected pigeons after they were fed infected *Bulinus africanus* (Krauss 1848). The echinostome cercariae which were shed by this snail bear a collar in which the number of spines varied between 48 and 54. Appleton *et al.* (1983) linked the echinostome described by Taplin (1964) to their material. In our opinion, it is unlikely that this cercaria with up to 54 spines was in fact part of the life cycle of the adult they described. As far as we know there is no record of an adult echinostome in which the number of spines differs from its larval form. Appleton *et al.* (1983) provide only scant morphological information which makes comparison difficult. The adults, however, have the same number and arrangement of collar spines as our material and previously described *E. elegans*. Although we doubt whether the cercariae shed by the bulinid used by Appleton *et al.* (1983) were in fact a larval stage of the 43-spined echinostome, the snails must have been infected by metacercariae of this species. The material Appleton *et al.* (1983) presented requires re-examination. In the meantime, however, we regard the adult they described as *E. elegans*.

The echinostome in the present study is placed within the species *E. elegans* for the following reasons. The number and arrangement of collar spines, general morphological similarities of all life stages, especially the reproductive system of the adult trematode, a bulinid snail acts as first intermediate host and the development of the metacercaria to maturity in a rodent. All the populations of echinostomes now regarded as *E. elegans* emanate from Africa and the Mediterranean region, while *E. dunni* was described from Malaya. As stated by Mouahid & Moné (1988): '*E. elegans*, therefore, remains the sole representative of the 43-spined *Echinoparyphium* group with a collar spine arrangement of 5-5-3-3-27 and utilising *Bulinus* Müller, 1781 as the first intermediate host'.

Bulinus in this country serves as first intermediate host for many digenetic parasites. Of these schistosomiasis is the best known, especially *Schistosoma haematobium* (Bilharz, 1852) which infects man, other primates and artiodactyls. *Schistosoma mattheei* (Veglia & Le Roux, 1929) infects cattle, sheep and other artiodactyls (also perissodactyls, rodents and man), *Schistosoma leiperi* Le Roux, 1955 infects cattle, sheep and other artiodactyls, and *Schistosoma margrebowiei* Le Roux, 1933 infects cattle, goats and wild artiodactyls. Interspecific antagonism between larval trematodes has been studied on various occasions (Heyneman, Lim & Jeyarasasingam 1972; Rysavy, Ergens, Groschaft, Moravec, Yousif & El-Hassan 1973; Jourdane & Kulo 1982; Jourdane 1983), to name but a few. The results of all of these studies indicated that echinostomatid parasites play a significant role, not only in delaying schistosome sporocysts to develop, but also in destroying, or partly destroying schistosome sporocysts. Although it was not the aim of this study to determine the effect of *E. elegans* on schistosomiasis in this country, it may well be time to look into the echinostome parasites in South Africa to determine their role as possible biological control agents against schistosomiasis.

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