

Surface morphology of the fish parasite *Chonopeltis victori* Avenant-Oldewage, 1991 and aspects of the histomorphology

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Luus-Powell, Wilmien and Annemarié Avenant-Oldewage. 1996. Surface morphology of the fish parasite *Chonopeltis victori* Avenant-Oldewage, 1991 and aspects of the histomorphology. *Koedoe* 39(1): 55-70. Pretoria. ISSN 0075-6458.

The ultrastructure and aspects of the histomorphology of *Chonopeltis victori*, parasitic on *Labeo rosae*, *L. congoro*, *L. ruddi*, *L. cylindricus* and *Barbus marequensis*, are described from scanning electron micrographs and transverse sections. *Chonopeltis victori* is characterised by sharply pointed tips of the abdomen which are directed outward. Sexual dimorphism is particularly evident from the structure of the natatory lobes on the fourth swimming legs and the accessory copulatory structures on the second, third and fourth swimming legs of males. The most striking feature on leg four of the male is the peg. The elevated peg appears tubular, but the sides are not fused. On the inner collar elliptical projections, each with a central, circular pore, are present. On the elongated outer collar small indentions occur peripherally. The dorsal surface of the peg is subterminally covered by elongated scales. The ventral surface of the thorax and swimming legs are covered with different shapes of posteriorly directed scales. Interspersed amongst these scales, as well as on the dorsal surface, eight types of setae are present in large numbers. The possible function of the peg and other structures are described.

Keywords: *Chonopeltis*, Branchiura, Africa, surface morphology, histomorphology, freshwater fish, *Labeo* sp., *Barbus* sp.

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Introduction

The class Branchiura contains four genera, namely *Argulus* Müller, 1785; *Dolops* Audouin, 1837; *Chonopeltis* Thiele, 1900 and *Dipteropeltis* Calman, 1912, and presently consists of not more than 200 described species (Overstreet *et al.* 1992). *Chonopeltis* is the only genus endemic to Africa and comprises 13 species of which *C. koki* Van As, 1992 is the most recent. Eight species have thus far been recorded from southern Africa, i.e. *C. inermis* Thiele, 1900; *C. meridionalis* Fryer, 1964; *C. australis* Fryer, 1977; *C. minutus* Fryer, 1977; *C. australissimus* Fryer, 1977; *C. fryeri* Van As, 1986; *C. victori* Avenant-Oldewage, 1991 (Avenant-Oldewage & Knight 1994) and *C. koki* Van As, 1992 (Van As 1992).

The first specimen of *Chonopeltis victori* found by Avenant-Oldewage (1991) was described with the aid of a light microscope. Studies with this apparatus are inadequate for the description of the ultrastructure and functional morphology of structures. For example, the different types and ornamentation found on scales, pores on the surface, the differentiation of setae, and the ultrastructure of the peg can be described more accurately using a scanning electron microscope (SEM) to reveal the possible function. Until now only *Chonopeltis fryeri* (Van As 1986), *C. koki* (Van As 1992) and *C. inermis* (Van As & Van As 1993) have been studied by means of SEM. These studies clearly showed, in particular, the copulatory structures on legs two to four of males. The present study aims to describe the ultrastructure

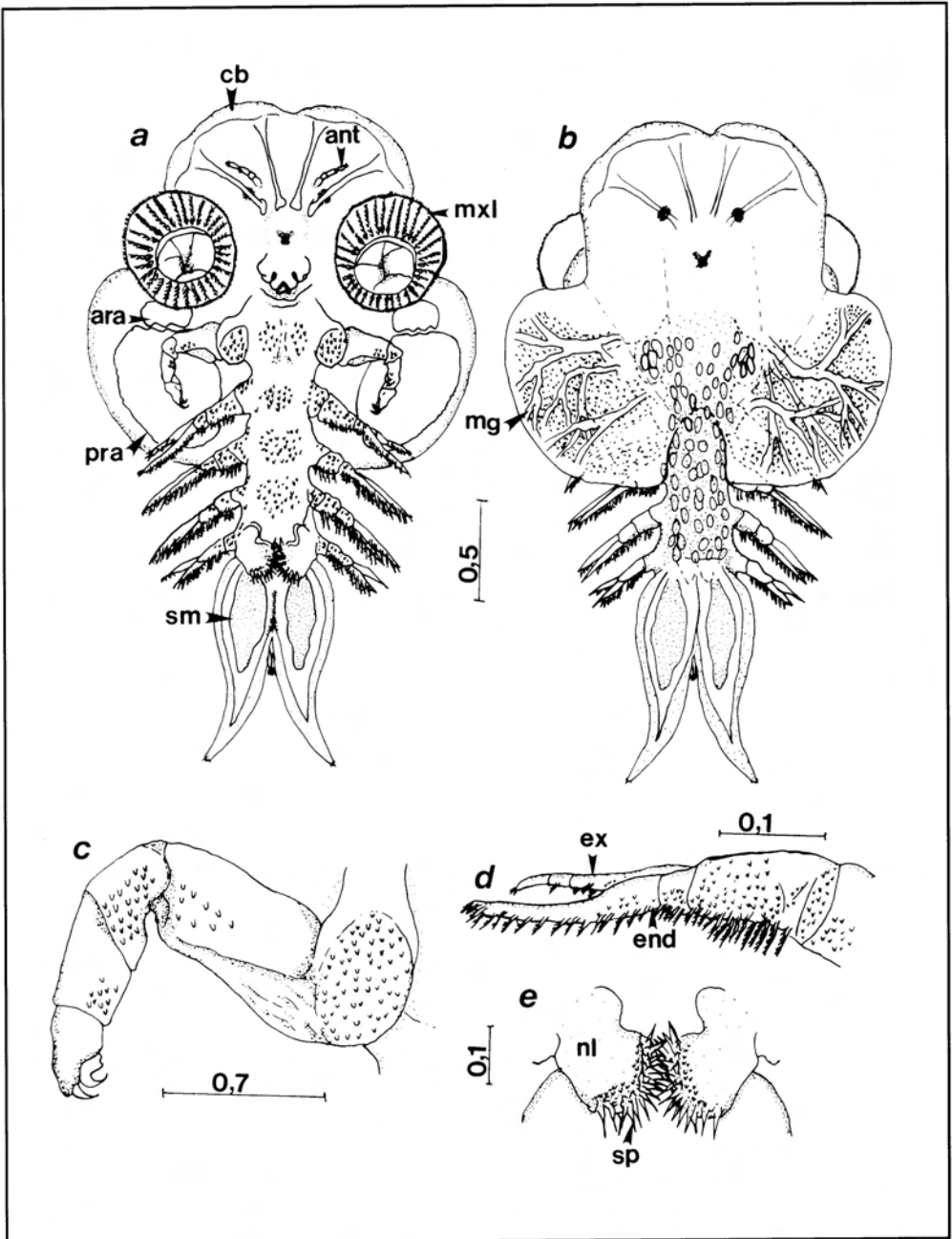


Fig. 1. *Chonopeltis victori*. Female. a, ventral view showing the chitinous band (cb), antenna (ant), maxillula (mxl), anterior respiratory area (ara), posterior respiratory area (pra) and spermatheca (sm); b, dorsal view showing the midgut gland (mg); c, maxilla, ventral; d, first swimming leg with endopodite (end) and exopodite (ex), ventral; e, natatory lobes (nl) with spine-like setae (sp), ventral. (Scale bar in mm)

of adult *C. victori*, using SEM, the light microscope, and serial sections. The function of the structures for feeding, copulation, as well as for the retention to its host is also pointed out.

Material and methods

Specimens of *C. victori* were collected from the body surface and fins of the cyprinids *Labeo rosae* Steindachner, 1894, *L. congoro* Peters, 1852 (= syn *L. rubropunctatus*), *L. ruddi* Boulenger, 1907; *L. cylindricus* Peters, 1852, and *Barbus marequensis* Smith, 1841. These specimens were collected in the Olifants River, in the Kruger National Park.

Following removal from the host, live specimens were washed in clean river water to remove mucus and debris. Specimens were fixed in steaming hot 10 % phosphate buffered neutral formalin and preserved in 70 % ethanol. The specimens prepared for scanning electron microscopy were rehydrated, freeze dried and sputter-coated with gold. Observations were made with an ISI SS60 scanning electron microscope, operating at 10 kV. Microdissections were made to reveal the mandibles, spermathecal spines and eggs.

Specimens to be studied with a light microscope were cleared in 90 % lactic acid and drawn with the aid of a drawing tube attachment. For histomorphological studies, specimens were dehydrated in an ascending series of ethanol solutions. The specimens were next infiltrated with Transmit LM (TAAB) resin (Spurr 1969), and embedded in fresh resin. Transverse serial sections, at a thickness of 5 μm , were obtained by cutting whole embedded specimens with glass knives fixed to a rotary microtome and sections were thereafter stained with Heidenhein's azan solution (Humason 1979).

Results

Adult female

Live specimens are transparent except for the eyes and median eye which are dark brown. Some specimens appear to be more brownish with distinct pigmentation patterns while others are transparent. These pigment spots, which contain melanophores, are spread dorsally over the entire abdomen and thorax, covering the reproductive organs. On the thorax they are arranged in two dark bands. Clusters of melanophores are also present near the proboscis. Due to size differences of these melanophores, pigmentation patterns differ amongst specimens

depending on the position of the parasite on the host and the functional status of the reproductive organs. Therefore, the colouration of *C. victori* differs from specimen to specimen. These pigmentation patterns as well as the transparency of the parasite can make them hard to detect against the silvery host. Fixed specimens lose their transparency and become milky white.

The body consists of three regions. The cephalon covered by the carapace, the sub-cylindrical thorax consisting of four segments – each bearing a pair of appendages with plumose setae, and the abdomen which is unsegmented and characterised by a pair of prominent posteriorly directed lobes (Figs. 1a & 1b).

The general body shape is elongated. The carapace covers the cephalon and part of the thorax, reaching back to cover the base of the second pair of legs (Fig. 1b). The carapace consists of three lobes, an anterior or cephalic lobe and two lateral lobes (Figs. 1b & 2a). The carapace is slightly flattened and fused with the first thoracic segment. On the dorsal surface a horseshoe-shaped suture separates the cephalic lobe from the remainder of the carapace (Fig. 2a). A pair of secondary sutures in the centre of the cephalic lobe extends posteriorly, parallel to each other. The dorsal surface of the carapace has an uneven wrinkled texture and a number of small setae (Fig. 4g) and circular pores are present. The anterior margin of the cephalic lobe is strengthened by a chitinous band with a central indentation (Fig. 1a). The cephalic lobe bears four chitinous supporting rods which protrude from the ventral surface (Fig. 2b). The elevated posterior ends of these rods are rounded and thicker than the remainder. Transverse sections through the rods show that they are heavily sclerotised and more so on the posterior ends of the rods (Fig. 2c).

Two compound eyes are covered by the two distal rods (Fig. 1b). They are large and darkly pigmented, which makes them clearly visible under a light microscope, but not visible under a scanning electron microscope as

they are covered by the supporting rods. It contains several ommatidia (Fig. 2c), each associated with a crystalline cone or lens as well as pigmented mantle cells, the retinules. Posterior to the compound eyes is the median eye, forming an equilateral triangle with the eyes (Figs. 1a & 1b). The median eye consists of three pigment cups, two anteriorly and one posteriorly, each containing an ocellus. The anterior cups are semi-circular with the posterior cup of same size but with extended lateral sides. The degree of darkness of the eyes and median eye varies from specimen to specimen. No "tearmarks" were noticed as indicated by Avenant-Oldewage (1991).

The two antennae are situated ventrally, next to each compound eye (Fig. 1a). The four distinct, slender segments of each are weakly sclerotised and decrease in size terminally (Fig. 2f). The terminal segment tapers and bears four setae (Fig. 2g). Three setae, the same size as those found on the terminal podomere, are found on the third podomere, and one on the second and first podomeres (all indicated by arrows) (Fig. 2f). A cluster of 12 - 16 setae ($n = 12$) is present at the base of each antenna (Fig. 2e).

The pre-oral cavity is enclosed by the proboscis, a short tubular structure which is dorso-ventrally flattened and situated mid-ventrally between the suckers (maxillulae) (Fig. 1a). The proboscis projects posteriorly from the body wall with the centre more elevated than the sides (Fig. 2i). It is probably formed by the fused labrum and metastome as suggested by Swanepoel & Avenant-Oldewage (1993) in their studies on *C. australis*. The labrum is much smaller than the crescent-shaped metastome and is embraced by it laterally. Small setae and circular pores are concentrated centrally on the surface of the labrum (Figs. 2i & 3a). It is indented medially with a single row of chitinous protrusions visible along the inner edges (Fig. 3a). These protrusions are considerably smaller than the denticles of the mandibles (Fig. 3b) and are arranged in groups from 1 to 5. The labrum is strengthened by a scler-

otised transverse labral bar. Between the labrum and the metastome a roughly triangular-shaped pre-oral opening leads into the pre-oral cavity.

The pair of well developed mandibles is concealed within the pre-oral cavity. They project medially and anteriorly from the lateral walls of the metastome, occupying the largest part of the pre-oral cavity. These sickle-shaped mandibles curve upwards anteriorly so that their distal parts reach towards the oral opening. Each tapers from base to apex, displaying rows of curved chitinous denticles on the convex side (Figs. 3b & 3c). The denticles curve towards the oral opening. A transverse section through the oral cavity reveals the mandibles as heavily sclerotised structures. In the region of the mandibles the roof of the pre-oral cavity is lined by numerous fine, chitinous seta-like projections, on the so-called tongue (Fig. 3a).

The metastome displays a single row of long setae peripherally, reminiscent of a fringe (Figs. 2i & 3a). From medial to lateral, the setae increase in size. The laterally situated


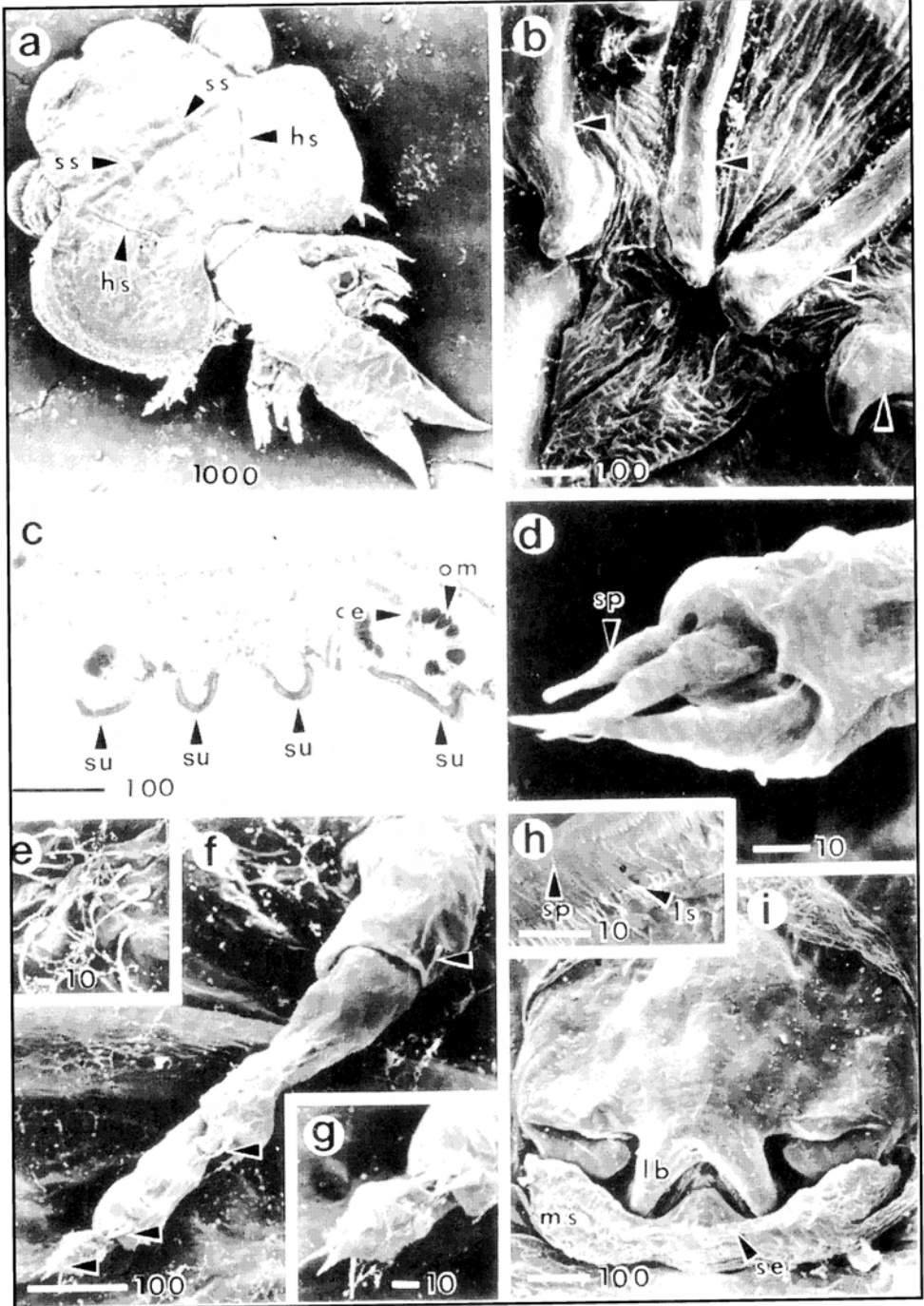
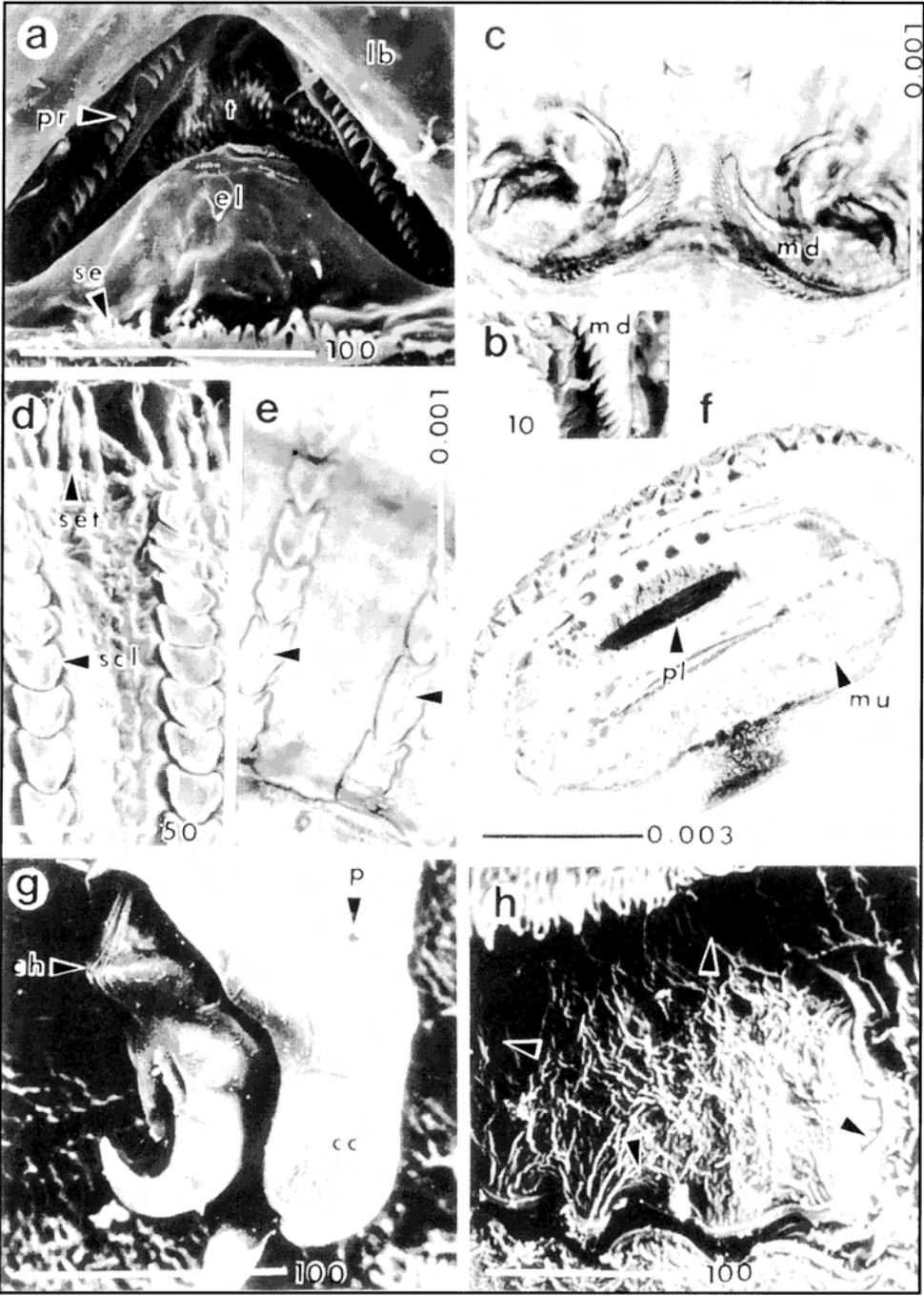


Fig. 2. Scanning electron micrographs and light micrographs of *Chonopeltis victori*. a, male, dorsal, showing the horseshoe-shaped suture (hs) and secondary sutures (ss); b, supporting rods, ventral; c, transverse section through cephalon showing supporting rods (su), compound eye (ce) and ommatidium (om); d, exopodite of first swimming leg with spine-like setae (sp); e, cluster of spine-like setae at base of antenna; f, antenna, ventral, indicating the spine-like setae on each segment; g, terminal and third segments of antenna, bearing four and three spine-like setae respectively; h, elongated setae (ls) (type eight) which appear to be partly fused with the surface of the metastome and the additional shorter spine-like setae (sp); i, proboscis, showing the labrum (lb) and metastome (ms) with setae (se) peripherally. (Scale bar in μm).





setae appear to be partly fused with the surface of the metastome (Fig. 2h). Additional, shorter, spine-like setae, arranged in groups of varying numbers, are present anterior to the single row of setae (Fig. 2h). Centrally, the metastome protrudes anteriorly to form an elevated structure inside the pre-oral cavity (Fig. 3a).

The maxillulae are transformed into large, functional cup-shaped suction discs, located on either side of the proboscis (Figs. 1a & 7a). Each sucker is a muscular, sclerotised organ, supported by a ring of complex radiating rods. Each sucker consists of 65-70 ($n = 12$) rows of chitinous supporting rods, each composed of 12-16 ($n = 12$) interlinked rib-like components (sclerites) (Fig. 3d). The elongated end of each sclerite protrudes into the next sclerite (Fig. 3e, indicated by arrows). This interlinked character of the chitinous components ensures that the sucker is firm but also flexible. The rim of the sucker carries terminally a single row of short setule-bearing setae (Fig. 3d). The sucker is situated on a flexible stalk which ensures that the sucker can move in any direction. The stalk is cylindrical with thin cuticle which is compressed to form typical

rings. The walls of the suction cup are lined with cuticle, both on the inside and outside. The outside cuticle is thin, while the inner is thicker and sclerotised. The inner wall provides the rigidity necessary to prevent the cup from collapsing. The floor of the sucker bears a thick sclerotised plate (indicated by arrow) with underlying mucus cells (Fig. 3f).

The ventral surface of the thorax and the thoracic appendages are covered by posteriorly directed scales. The scales present on the maxilla, thorax, pre-coxa-, coxa- and basipodite are similar in structure but differ slightly in size. These scales are C-shaped and bear numerous fine, comb-like teeth on their distal ends (Fig. 4c). The scales found on the exo- and endopodite of the swimming legs differ from those described above. Those present on the dorsal surface are fused with the surface of the endo- and exopodite, each scale is situated on an elevated area (Fig. 4b). Those on the ventral surface are comb-like and bear three to four spine-like protrusions on the distal ends (Fig. 4a).

Interspersed amongst these scales, presumed sensory structures are found in large numbers. Eight types of structures appear on the dorsal and ventral surfaces:

1. spine-like setae which taper terminally (Figs. 1e, 2d, 2e, 2f, 2g, 2h & 4i);
2. finger-like setae bearing setules terminally (Fig. 3d);
3. long, flattened setae surrounded by a sunken circular area (Fig. 4d);
4. plumose setae with a single row of setules (Fig. 4e);
5. sunken seta surrounded by an elevated circular pit (Fig. 4f);
6. setae arising from small cuticular pits with broad bases which taper terminally into hair-like setae (Fig. 4g);
7. papillae-like setae arising from the surface (Fig. 4j), and
8. elongated setae arising from the surface (Fig. 6i), or which are partly fused with the surface (Fig. 2h).

Type one is present on the podomeres and at the base of the antennae, on the metastome, terminal on the exopodite of the first swimming leg and on the natatory lobes of

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 Fig. 3. Scanning electron micrographs and light micrographs of *Chonopeltis victori*. a, pre-oral cavity showing the labrum (lb), setae on the metastome (sc), chitinous protrusions (pr), elevated structure (el) and the tongue (t); b, mandibles (md) following removal of labrum by microdissection; c, light micrograph showing mandibles (md); d, maxillula with rows of chitinous supporting rods composed of sclerites (scl) and setule bearing finger-like setae (set) terminally; e, maxillula showing elongated end of each sclerite inside the next sclerite (indicated by arrows); f, transverse section through the maxillula with a thick sclerotised plate (pl) and mucus cells (mu); g, maxilla with chitinous knobby base of claw (ch), chitinous cap (cc) and large circular pore (p); h, respiratory areas. (Scale bar in μm , except c, e and f, which is in mm).

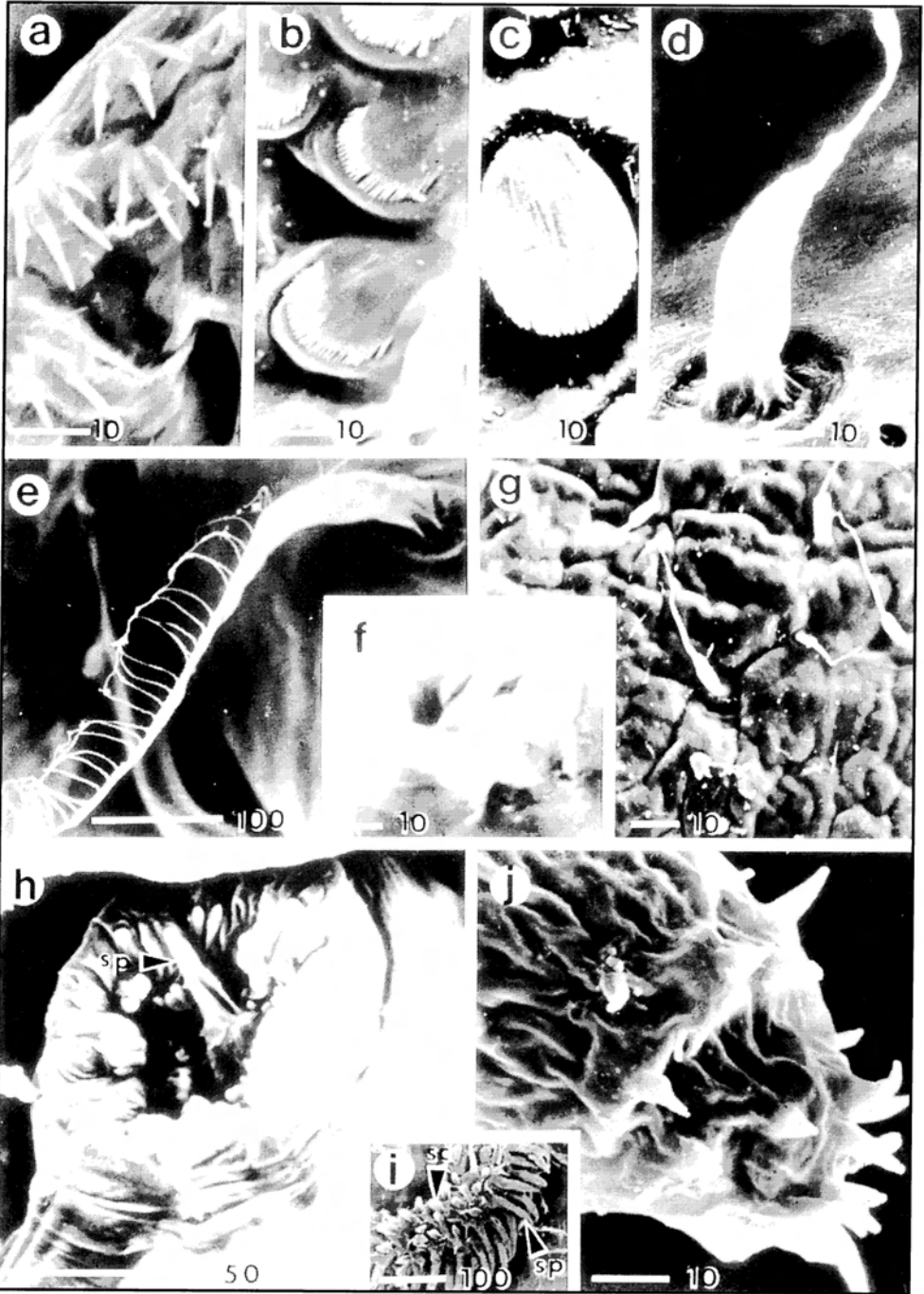


Fig. 4. Scanning electron micrographs of *Chonopeltis victori*. a, comb-like scales present on the ventral surface of endo- and exopodites; b, scales present on the dorsal surface of the endo- and exopodites; c, C-shaped scales with fine comb-like teeth on their distal ends; d, seta, type three; e, seta, type four; f, seta, type five; g, setae, type six; h, sharply pointed spermathecal spine (sp) surrounded by a circular elevated area; i, C-shaped scales (sc) and elongated spine-like setae (sp) on the natatory lobe of female; j, tip of abdominal lobe with papillae-like setae, type seven. (Scale bar in μm).

female. The second type is present on the rim of the maxillulae. The third type occurs on the pre-coxa- and coxapodite of the second pair of swimming legs of males, and the fourth type on the postero-ventral surface of all the swimming legs. The fifth type is situated on the ventral surface of the socket of males (a single seta was found, situated approximately medial). The sixth type is interspersed among the scales on the ventral surface of the thorax and on the dorsal surface of the carapace. The seventh type can be found on the tip of each abdominal lobe and the eighth on the tip of the furcal rami and metastome.

The maxillae are robust, prehensile and consist of five podomeres with scabrous areas, bearing large C-shaped scales on the first, second, third and fourth podomeres (Fig. 1c). The scales on the first podomere are arranged in a characteristic round patch, while those of the other podomeres are concentrated randomly at the postero-ventral side. The second podomere is extended and forms the largest podomere of the maxillae.

The total length of the last three podomeres is only slightly greater than the length of the second podomere. The second and third podomeres are joined in such a way that an indentation forms at the postero-ventral side. A knick-point is formed between the second and third podomere which gives the maxilla its prehensile structure. The joints between the third and fourth, as well as the fourth and fifth podomeres of the maxilla, indicate that there are limited articulation between these podomeres. The fifth podomere terminates into two sharp claws (Figs. 1c & 3g) which aid the suckers in clinging to the host by insertion of the claws into the host's flesh. The last podomere bears a chitinous cap anterior to the claws. The basis of the claws forms an extended chitinous knob (Fig. 3g). A large circular pore is present on the last podomere (indicated by arrow).

A large, compact glandular mass, the midgut glands, in the lateral lobes of the carapace can be seen under a light microscope. Each midgut gland consists of numerous finger-

like tubuli branching randomly into the carapacial spaces (Fig. 1b). The tubular ducts drain into larger ducts which eventually unite to form the main duct which opens laterally into the anterior midgut.

The respiratory areas are sharply demarcated from the remainder of the carapace (Figs. 1a & 3h). Two pairs of these areas occur on the ventral surface of the lateral lobes. The posterior areas are kidney-shaped, while the much smaller anterior areas are elliptical (Figs. 1a & 7a). These two areas are not fused but the coiling edges are formed in such a way that they fit into each other (Fig. 3h). The surface texture of these areas are rougher than the remainder of the carapace and somewhat elevated. Transverse sections through this area indicate an area of thin cuticle (integument) and large epithelial cells (Fig. 5c).

The thorax consists of four segments. The segmentation is visible and distinct (Fig. 2a). Dorsally it is devoid of surface ornamentation, except for the random arrangement of a few small setae and circular pores similar in size and structure to those on the carapace (Fig. 4g). The four pairs of biramous legs are segmented and well developed. Each leg consists of a protopodite consisting of a pre-coxa-, coxa- and basipodite (Fig. 6e). The latter terminates in an exopodite and a slightly shorter endopodite.

The legs are evenly spaced and well separated (Fig. 1a). Legs two to four are similar in structure. The legs decrease slightly in size posteriorly. On each leg the coxa-, basi-, endo- and exopodite have a single row of long, stout pinnate (plumose) setae on the postero-ventral surface (Fig. 4e). The number of setae varies from leg to leg. The exopodite of the first leg is considerably shorter than the endopodite and consists of three segments (Fig. 1d). The terminal segment lacks the plumose setae and scales present on the other segments and terminates into three spiny setae, probably used for holding and grooming (Fig. 2d).

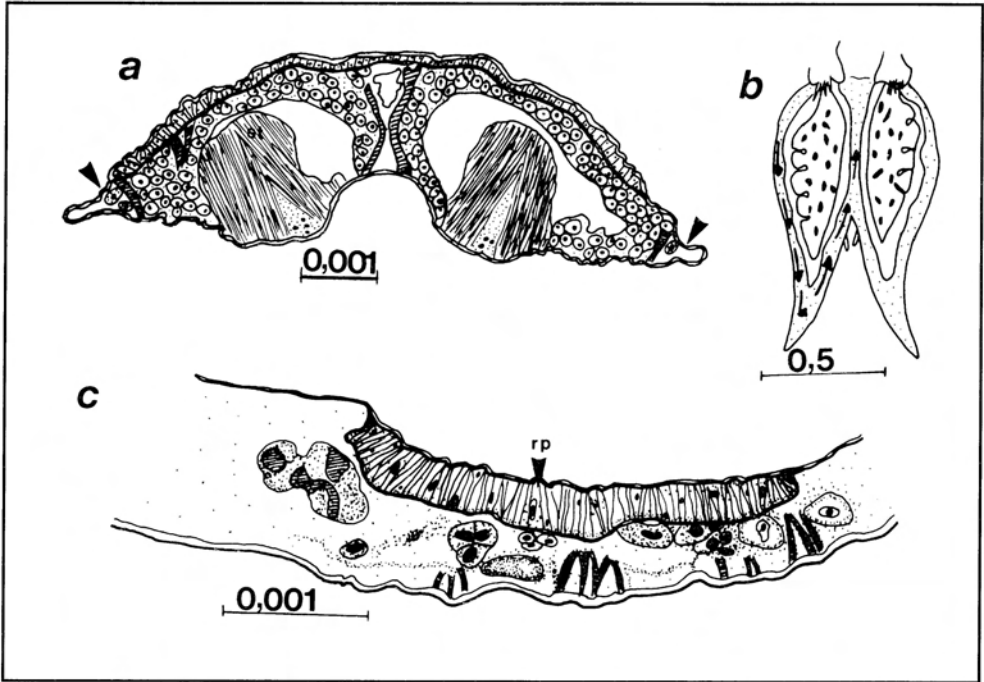


Fig. 5. *Chonopeltis victori*. a, transverse section through the abdominal region, showing the spermatids (st) and the region where blood cells can be observed microscopically (indicated by arrows); b, abdomen, ventral, arrows indicating blood flow as seen lightmicroscopically; c, transverse section through the carapace showing the respiratory area (rp). (Scale bar in mm).

The coxapodite of leg four extends posteriorly to form the natatory lobes. These lobes are broad and laterally rounded and bordered peripherally by elongated spine-like setae without setules (Figs. 1e & 4i). C-shaped scales, similar to those found on the ventral surface of the maxilla, thorax and swimming legs, are present on the ventral thickened surface of the natatory lobes (Fig. 4j).

The abdomen is a flexible, bilobed, unsegmented structure. The lobes taper to sharply pointed tips which are directed outward. It is slightly wider than the thorax (Figs. 1a, 1b & 7a) and appears transparent peripherally. Blood-flow can be observed through this

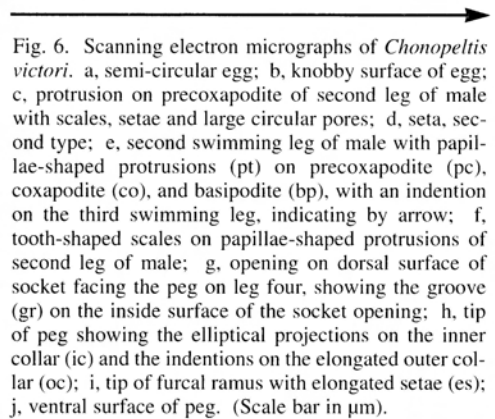
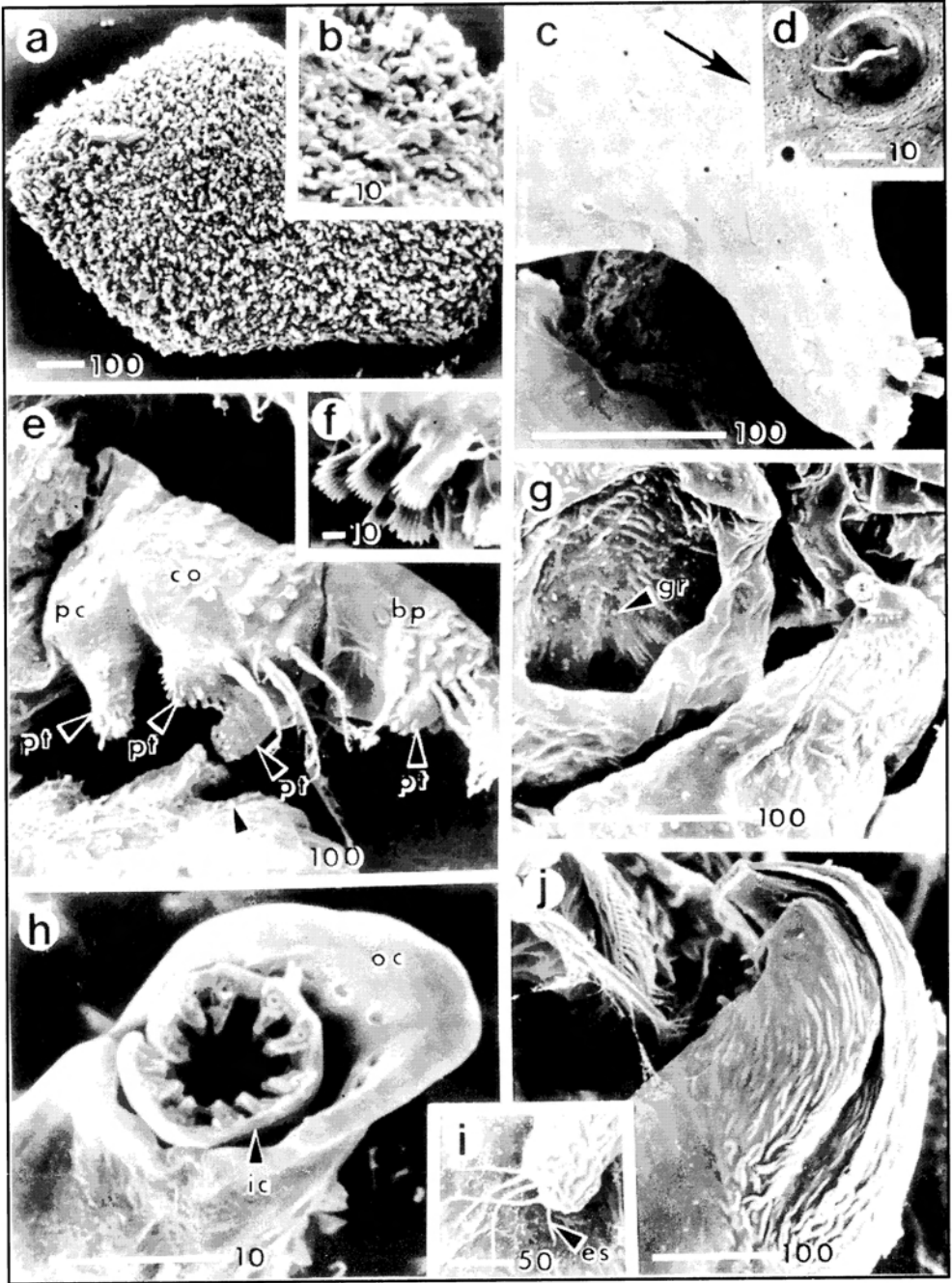


Fig. 6. Scanning electron micrographs of *Chonopeltis victori*. a, semi-circular egg; b, knobby surface of egg; c, protrusion on precoxapodite of second leg of male with scales, setae and large circular pores; d, seta, second type; e, second swimming leg of male with papillae-shaped protrusions (pt) on precoxapodite (pc), coxapodite (co), and basipodite (bp), with an indentation on the third swimming leg, indicating by arrow; f, tooth-shaped scales on papillae-shaped protrusions of second leg of male; g, opening on dorsal surface of socket facing the peg on leg four, showing the groove (gr) on the inside surface of the socket opening; h, tip of peg showing the elliptical projections on the inner collar (ic) and the indentions on the elongated outer collar (oc); i, tip of furcal ramus with elongated setae (es); j, ventral surface of peg. (Scale bar in μm).



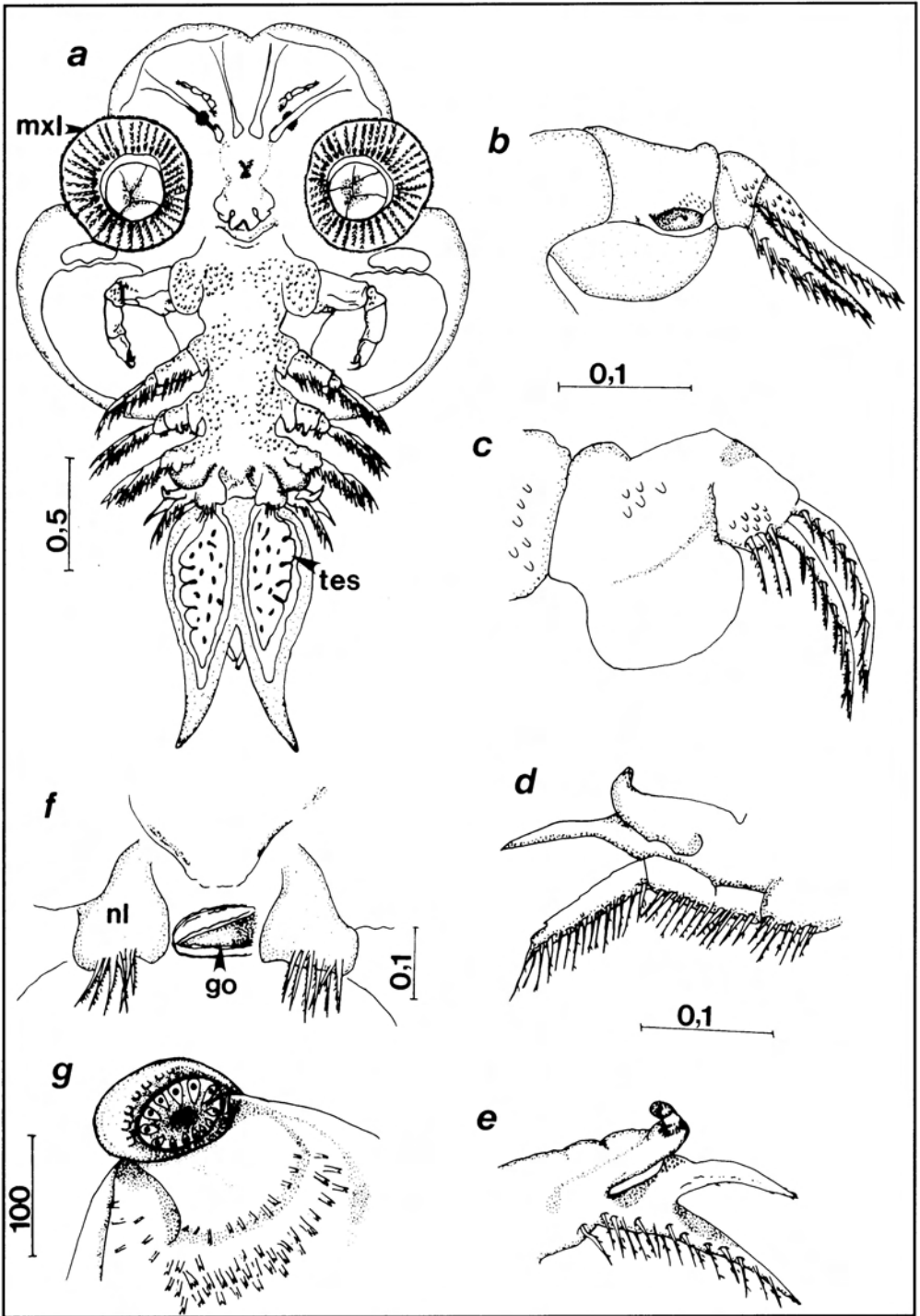


Fig. 7. *Chonopeltis victori*. Male. a, ventral view showing the maxillula (mxl) and testis (tes); b, third swimming leg, dorsal; c, third swimming leg, ventral; d, fourth swimming leg, ventral; e, fourth swimming leg, dorsal; f, natory lobes (nl) and genital opening (go), ventral; g, tip of peg, dorsal. (Scale bar in mm, except g, which is in μm).

area (Fig. 5b). Blood cells are present in the same area in a transverse section (Fig. 5a). A transverse section through the carapace also indicates a layer of thin cuticle ventrally covering the respiratory areas. This layer is similar in thickness to the one surrounding the abdomen.

The anus is situated in the cleft between the two abdominal lobes. Furcal rami, with large elongated setae on the tip of each ramus (Fig. 6i), are situated near the base of the cleft. They are papillated, finger-like processes originating from the ventral surface of the abdomen. The tips of the abdominal lobes are covered by numerous short, papillae-like setae (Fig. 4j). Two sharply pointed spermathecal spines, covered by the natatory lobes, are situated on the abdomen. These spines are surrounded by a circular elevated area and appears to be partly immersed (Fig. 4h). On the side of each spine an aperture is present, much like the aperture of a hypodermic needle. Similar apertures were noted on the spermathecal spines of *Dolops ranarum* (Avenant *et al.* 1989). The spermathecal ducts in *D. ranarum* which are connected to the spermathecae open into these spines (Avenant *et al.* 1989).

Females can be recognised by a pair of spherical or elongated spermathecae, extending to the cleft in the proximal third of the abdomen (Figs. 1a & 1b). The spermathecae are enclosed in a thick-walled sac with smooth margins. When studied under a light microscope, numerous large eggs are clearly visible, medially in the thorax. These eggs reach up to the proboscis and to the first podomeres of the maxillae (Fig. 1b). After laceration of the thorax surface, numerous eggs were revealed. The semicircular eggs have a knobby surface (Figs. 6a & 6b).

Adult male

Males can be distinguished from females by the presence of paired testes, as well as the accessory sclerotised processes on the second, third and fourth swimming legs. Adult males are typically smaller than females, and they are generally less numerous. The gen-

eral shape of the male is similar to that of the female. Cephalic appendages and first pair of legs resemble those of female. Legs two, three and four are modified to form copulatory structures.

Legs one and two are of the same size, leg three is slightly shorter with leg four considerably shorter (Fig. 7a). The second pair of legs differs from those of females as papillae-shaped protrusions occur on the posterior face (Fig. 6e). One distinctive bulbous protrusion is present on the precoxapodite (Figs. 6c & 6e). Tooth-shaped scales with partly fused comb-like teeth on the distal ends cover the tip of the protrusion peripherally (Fig. 6f). Small setae appear interspersed between the above-mentioned scales. Large circular pores and long, flattened, hair-like setae are spread at random across the protrusion (Figs. 6c & 6d). Two protrusions, of different sizes, in association with three long plumose setae occur on the coxapodite (Fig. 6e). The tips of these protrusions are also covered by setae and scales similar to those present on the first protrusion. Circular pores are less abundant than on the first protrusion. One less-distinctive protrusion, covered by scales similar to those on the other protrusions, is present on the basipodite.

The ventral surface of the coxapodite of the third leg is enlarged to form a posteriorly directed socket (Figs. 7b & 7c). The socket has a large slit-like opening on the dorsal surface, facing the peg on leg four (Fig. 6g). On the inside surface of the opening a single groove occurs medially (Fig. 6g). On the antero-dorsal surface of the socket, as well as on the inside, various short setae and circular pits are present. Anteriorly, on the ventral surface of the coxapodite of leg three, two elevated areas are present. An indentation (indicated by arrow, Fig. 6e) which corresponds with the larger protrusion on leg two is also present on the coxapodite of leg three. These latter structures, together with the scabrous area on leg three, probably grasp the female's second leg during copulation.

The most striking feature of leg four, mostly only visible from dorsal view as it is shel-

tered by the socket, is the peg. The elevated peg has a cylindrical shape and appears tubular, but the sides are not fused (Fig. 6j). The peg consists of an inner and outer collar. On the inner collar of the peg 11 - 13 ($n = 7$) elliptical projections are present (Figs. 6h & 7g). These projections are partly fused with the inner collar and each bears a single circular pore. On the elongated outer collar small indentations occur peripherally (Fig. 6h). The dorsal surface of the peg is subterminally covered by elongated finger-like scales with two to four comb-like sharply pointed protrusions on their distal ends. These scales become progressively smaller towards the tip of the peg (Figs. 6g & 7g). Endopodites of leg four are similar to those of the other legs. The exopodite forms a robust structure consisting of a proximal elevation (Fig. 7e) covered by scales similar to those present on the peg. Some specimens lack these elongated scales and bear only spine-like setae. The distal extension of the exopodite is without scales, but bears small spine-like setae.

The natatory lobes are smaller than those of the female and carry five to seven setae with setules on the posterior edge (Fig. 7f). These setae are similar to those on the endo- and exopodites of the swimming legs. A small amount of scales, similar to those on the natatory lobes of the female, are present on the ventral surface of the natatory lobes of some specimens. The genital opening is situated between the two natatory lobes, at the bases of the fourth swimming legs, similar to the position of the gonopore in females.

The male abdomen constitutes a larger portion of the total length than that of the female. The testes are elongated, ellipsoid organs aligned longitudinally in the abdominal lobes adjacent to the midline, and occupy more than two-thirds of the length of the abdomen. The lateral capsular walls of the testes are undulated (Fig. 7a). Dorsally, large numbers of giant, elliptical melanophores cover the testes and remaining male reproductive organs situated in the thorax.

Melanophores are also present ventrally, but less abundant. Furcal rami as in female (Fig. 6i).

Discussion

At the base of the antennae of some *Chonopeltis* species, i.e. *C. fryeri* (obtained from figure) (Van As 1986); *C. koki* (Van As 1992) and *C. inermis* (Van As & Van As 1993), a cluster of setae is present. *C. victori*, as well as *C. australis* (own unpublished record), also bear this cluster of setae. In the past the cluster of setae was referred to as rudimentary antennules (Fryer 1956). However, when studying the larval development of *C. brevis*, Fryer (1961) could not find any of these setae. He suggested that these setae are mere ornamentation and not rudimentary antennules, which implies that *Chonopeltis* lacks the first pair of antennae which are present in all the other genera of the Branchiura.

The mouthparts of *C. victori* resemble those of *C. australis*, but lack the hand-shaped protrusion at the base of the mandible (Swanepoel & Avenant-Oldewage 1993). It can be assumed that they function in a similar manner. The latter authors noted that the mandibles appear to be capable of eversion-inversion movements only, suggesting that they are used to scrape mucus and cellular detritus from the skin of the host while everted, and to cram food into the pre-oral cavity during inversion. The mandibles are thus used for removing mucus, rather than for piercing the skin of the host. The tongue probably cleans the mandibles.

Van As (1992) mislabelled the chitinous denticles (as termed by Swanepoel & Avenant-Oldewage 1993) as mandibles. Swanepoel & Avenant-Oldewage (1993) annotated the chitinous protrusions (see Figure 3a) as chitinous denticles and used the same term, i.e. denticles, for the structures on the mandibles. To avoid further confusion it is proposed that the term chitinous protrusions be used for the protrusions on the inside of the rim of the incision of the labrum, and the

denticles on the mandibles, the chitinous denticles.

The functional importance of the different types of scales is still not clear but they certainly aid in the retention of the parasite on the body surface and fins of the host. The simple setae are presumably sensory, especially those present on the metastome, as they are the first structures in contact with the host.

Concerning the function of the peg structure, there is much confusion. Different functions have been given to the peg structures of *Chonopeltis* and *Argulus* species by previous authors (Claus 1875; Jurine 1806; Van As & Van As 1993). Van As & Van As (1993) suggested that the peg on leg four might be a sperm transferring instrument. However, in none of the histological sections of *C. victori* or *C. australis* specimens previously studied (Avenant-Oldewage & Knight 1994), could a connection be found between the peg structure and the reproductive system. We agree with Avenant-Oldewage & Knight (1994) that it is impossible for the peg to reach the genital opening to collect sperm. According to Wilson (1902) the socket of *Argulus* receives sperm, and Claus (1875) added that the peg ("hook") of *A. foliaceus* assists in opening the socket ("semen capsule") during sperm transference. However, in none of the histological sections of male individuals of *C. victori* could sperm be found in the socket structure. In our opinion it will be impossible for the male to place the sperm into the socket and for the female to collect the sperm from the socket.

Fryer (1968) in dealing with *Chonopeltis* and *Argulus* species, and Martin (1932), working on *Argulus viridis*, suggested that claspers, developed on the second, third and fourth thoracic appendages of the male, are used to grasp the female during mating. We agree with that but suggest that during mating the third and fourth leg of the male embraces the fourth leg of the female from her dorsal aspect by inserting the peg into the socket. The elliptical projections on the inner collar

as well as the elongated scales on the dorsal surface of the peg, prevent the peg from gliding from the socket opening. The female is thus held firmly in position during copulation.

Presumably males of *A. rubropunctatus* uses their prehensile maxillae to assist in the copulation process (Fryer 1968), but prehensile maxillae are present on both males and females of *Chonopeltis* species and thus indicate another function. The maxillae are presumably used for cleaning debris from the plumose setae on the swimming legs. Van Niekerk & Kok (1989) stated that the maxillae of *C. australis* plays an important role during mating, but they did not expand on the role.

Acknowledgements

We are grateful for the financial support given by the Rand Afrikaans University, FRD and IWQS, for logistic support given by National Parks Board personnel and WJL-P's fellow students at RAU, and to Dr W.H. Oldewage for help with SEM.

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