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# *Kroyeria deetsi* n.sp. (Kroyeriidae: Siphonostomatoida), a parasitic copepod infecting gills of spinner sharks, *Carcharhinus brevipinna* (Müller & Henle, 1839), in the Indian Ocean

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***Kroyeria deetsi* n.sp. (Kroyeriidae: Siphonostomatoida) is described from both sexes collected from the gills of spinner sharks, *Carcharhinus brevipinna* (Müller & Henle, 1839), captured in the Indian Ocean off the coast of South Africa. *Kroyeria deetsi* n.sp. can easily be distinguished from all of its congeners because the third endopod segments of legs 1–4 of the new species are about twice (legs 1, 2 and 4), or more than twice (leg 3), as long as the corresponding second endopod segments in the female.**

**Key words:** Kroyeriidae, *Kroyeria deetsi*, spinner shark, Indian Ocean.

## INTRODUCTION

The Kroyeriidae (Siphonostomatoida) is a family of parasitic copepods whose three genera contain species that only infect the gills or olfactory organs of chondrichthyan fishes (Deets 1987). In establishing the Kroyeriidae, Kabata (1979) considered *Kroyeria* van Beneden, 1853, to contain 13 species. Subsequently, Deets (1994) described five new species in his revision of *Kroyeria*, and since then there have been no taxonomic changes to this genus.

This paper describes a new species of *Kroyeria* collected from the gills of spinner sharks caught in barrier nets set off South Africa by the Natal Sharks Board.

## MATERIALS & METHODS

Copepods were collected from the gill filaments of spinner sharks captured in shark nets set off the Uvongo and Glenmore coasts. Copepods were fixed and preserved in 70 % ethanol and subsequently studied using the wooden slide technique of Humes & Gooding (1964). Before being dissected, the copepods were cleared in lactic acid into which a pinch of lignin pink was dissolved. Measurements were made using an ocular micrometer and drawings were made with the aid of a camera lucida. One adult female was studied using scanning electron microscopy. This specimen was prepared for sputter-coating (gold-palladium) by placing it in 100 % ethanol (two changes, 1 h each) followed by immersion in a small volume of hexamethyldisilazane (15 min). Before mounting on metal stubs with double-sided tape, critical point drying was achieved by placing the specimen under slight vacuum to remove the hexamethyldisilazane. Anatomical terminology conforms mostly to that of Kabata (1979).

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### *Kroyeria deetsi* n.sp., Figs 1–5

*Female* (Figs 1–3). Overall length of holotype approximately 6.9 mm. Cephalothorax composed of cephalon and first two thoracic segments, ventrally bearing cephalic appendages, maxillipeds, and first pair of swimming legs. Dorsal shield (Fig. 1a) broad and roughly triangular, divided into frontal and two lateral regions by two heavily sclerotized sutures arising anterolaterally and uniting medially. Eyes not evident. Posterolateral sinus formed on each side of dorsal shield by extensions of lateral regions. Posterodorsally directed dorsal stylets articulating with cephalothorax within posterolateral sinuses. Dorsal stylets

(Fig. 1c) long, projecting almost to junction of second and third free thoracic segments (Fig. 1a), with some sculpturing on lateral margin near apex (Fig. 1c). Three free thoracic segments each with shield-like exoskeleton with medial suture (Fig. 1a), segments decreasing slightly in width from first to third, each segment ventrally bearing a pair of swimming legs (i.e. legs 2–4). Genital complex (Fig. 1a) of holotype about 58 % of total body length, resembling genital complexes of most congeners in being a relatively straight cylindrical tube bearing vestigial fifth legs laterally at about mid-length and two small posterolateral protuberances flanking abdomen. Abdomen (Fig. 1a) indistinctly three-segmented, first and second segments about equal in length and each about twice as long as terminal segment (caudal rami included in latter). Caudal ramus (Fig. 1b) flat, longer than wide, with medial fringe of setules and six terminal setae. Fine details of some setae difficult to interpret; however, elements seem to be as follows: one tiny naked (?) dorsal seta, followed by two long pinnate setae, one shorter seta with setules on medial border, one short naked (?) seta, and one short and thin pinnate seta located at distolateral corner.

First antenna (Fig. 1d) indistinctly seven-segmented, number of seta-like elements observed on segments (base to apex) as follows: 8, 5, 2, 4, 1, 1, 13. Second antenna (Fig. 1e) four-segmented and chelate; third segment robust, forming main corpus of chela, distal projection with small membrane-rimmed cup at tip that can receive tip of opposing fourth segment; fourth segment a robust claw bearing one small seta near mid-point. Mouth-tube (Fig. 2a) typical for genus, labrum bearing lateral patches of fine denticles and proximal setules. Mandible (Fig. 1f) with seven teeth, not all same size. First maxilla (Fig. 1g) biramous, exopod small with two short naked setae, endopod larger with two long setae bearing lateral rows of spinules. Second maxilla (Fig. 1h) brachiform; lacertus robust. Brachium distally swollen, bearing a tuft of setules near base of calamus and two patches of fine denticles. Calamus claw-like, sides rimmed by thin serrated membranes. Maxilliped (Fig. 1i) subchelate, corpus maxillipedis–subchela joint can extend beyond lateral aspect of cephalothoracic shield (Fig. 1a). Corpus two-segmented, robust and unarmed except for small distolateral flange. Subchela not obviously divided into shaft and claw but having overall claw-like appearance. Subchela with two flap-like membranes laterally about bend (Fig. 2b), terminating distally at a setule (Fig. 2c).

Leg 1 (Fig. 3a) biramous, interpodal bar without stylets, coxa unarmed, basis bearing two narrow distal membranes, short distal pinnate seta, and short lateral pinnate seta. Endopod (Fig. 3a) three-segmented; first segment with long distomedial pinnate seta, lateral membrane, and scattered setules along lateral border; second segment with nine large denticles and scattered setules along lateral border, denticles connected by cuticle (e.g. Fig. 2d); third segment twice as long as second segment, bearing six pinnate setae along medial apical border, and 17 large denticles along lateral border (proximalmost and distalmost denticles difficult to see in some views). Exopod (Fig. 3a) three-segmented; first segment bearing a medial patch of setules, long medial pinnate seta, small distolateral spiniform seta, and narrow lateral membrane; second segment bearing long medial pinnate seta and narrow lateral membrane; third segment bearing narrow lateral membrane, short distolateral spiniform seta, distolateral seta with lateral membranes, and four pinnate setae along apical to medial margin. Leg 2 (Fig. 3b) biramous, interpodal bar with long stylets, coxa unarmed, basis bearing two narrow membranes, and short lateral pinnate seta. Endopod (Fig. 3b) three segmented; first segment with narrow lateral membrane, few scattered lateral setules, and long medial pinnate seta; second segment with 10 denticles along lateral border and scattered lateral setules; third segment about twice as long as second segment, with six pinnate setae abo medial to apical margin, and 19 large lateral denticles (proximalmost and distalmost denticles difficult to see in some views). Exopod (Fig. 3b) three-segmented; first segment with medial patch of setules, long medial pinnate seta, small distolateral spiniform seta, and narrow lateral membrane; second segment with long medial pinnate seta, short distolateral spiniform seta, and narrow lateral membrane; third segment with narrow lateral membrane followed by small spiniform seta, short seta with thin lateral membranes, seta with thin membrane along lateral border and setules along medial border, and four longer pinnate setae along apical to medial margin. Leg 3 (Fig. 3c) biramous, interpodal bar with long stylets, coxa unarmed, basis bearing two narrow membranes, and tiny lateral pinnate seta. Endopod (Fig. 3c) three-segmented; first segment with

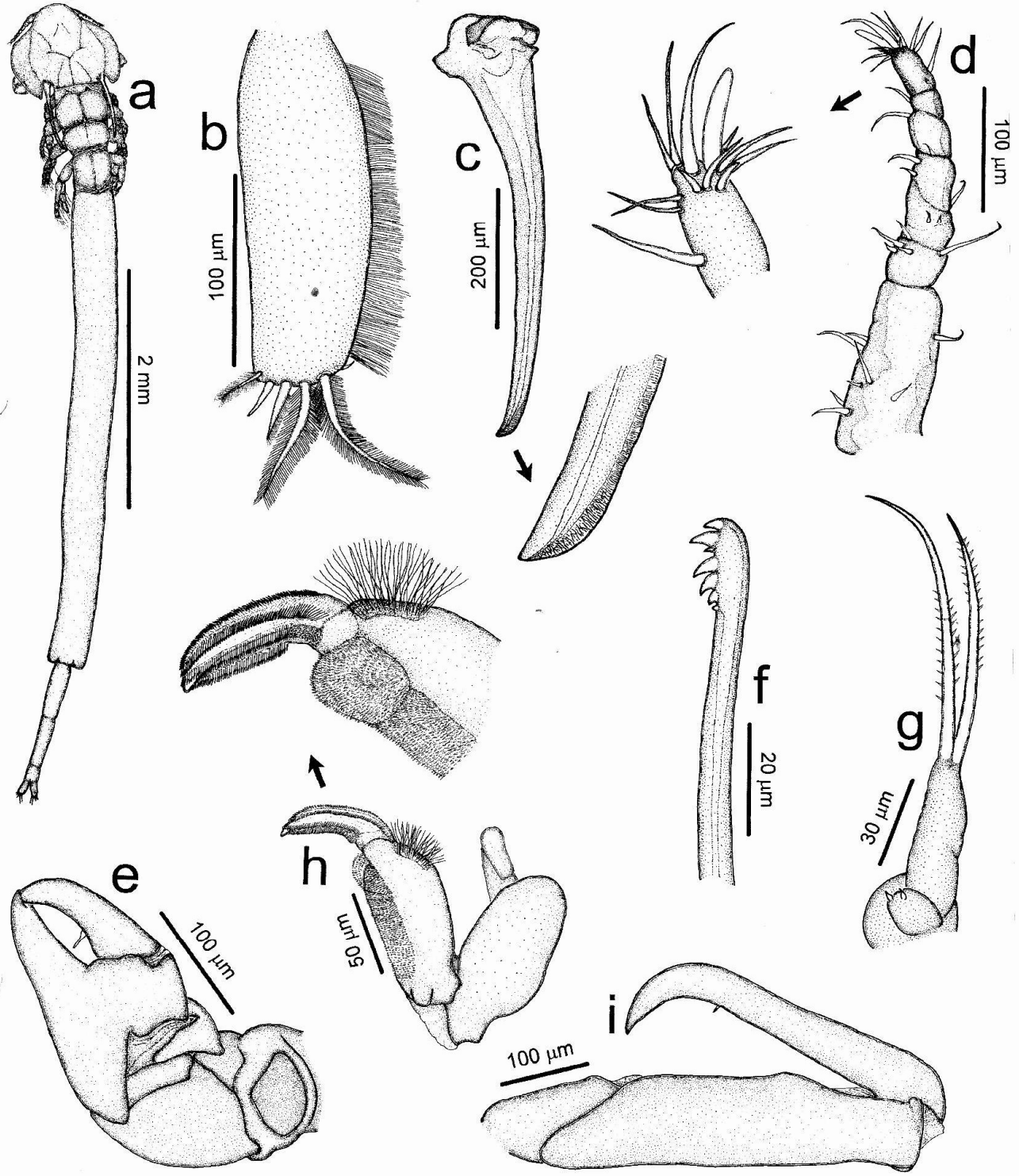


**Fig. 1**. *Kroyeria deetsi* n.sp., adult female. **a**, General habitus, dorsal; **b**, caudal ramus, ventral; **c**, dorsal stylet, tip enlarged (arrow); **d**, first antenna, tip enlarged and rotated (arrow); **e**, second antenna; **f**, tip of mandible; **g**, first maxilla; **h**, second maxilla, distal end enlarged (arrow); **i**, maxilliped.

narrow lateral membrane, few scattered lateral setules, and long medial pinnate seta; second segment with 10 denticles along lateral border and scattered lateral setules; third segment more than twice as long as second segment, with four pinnate setae along medial to apical margin and 19 large denticles along lateral border (proximalmost and distalmost denticles difficult to see in some views). Exopod of leg 3 (Fig. 3c) similar to exopod of leg 2. Leg 4 (Fig. 3d) biramous; interpodal bar with long stylets, coxa unarmed, basis bearing one narrow membrane between endopod and exopod. Endopod (Fig. 3d) three-segmented; first segment with narrow lateral membrane, few

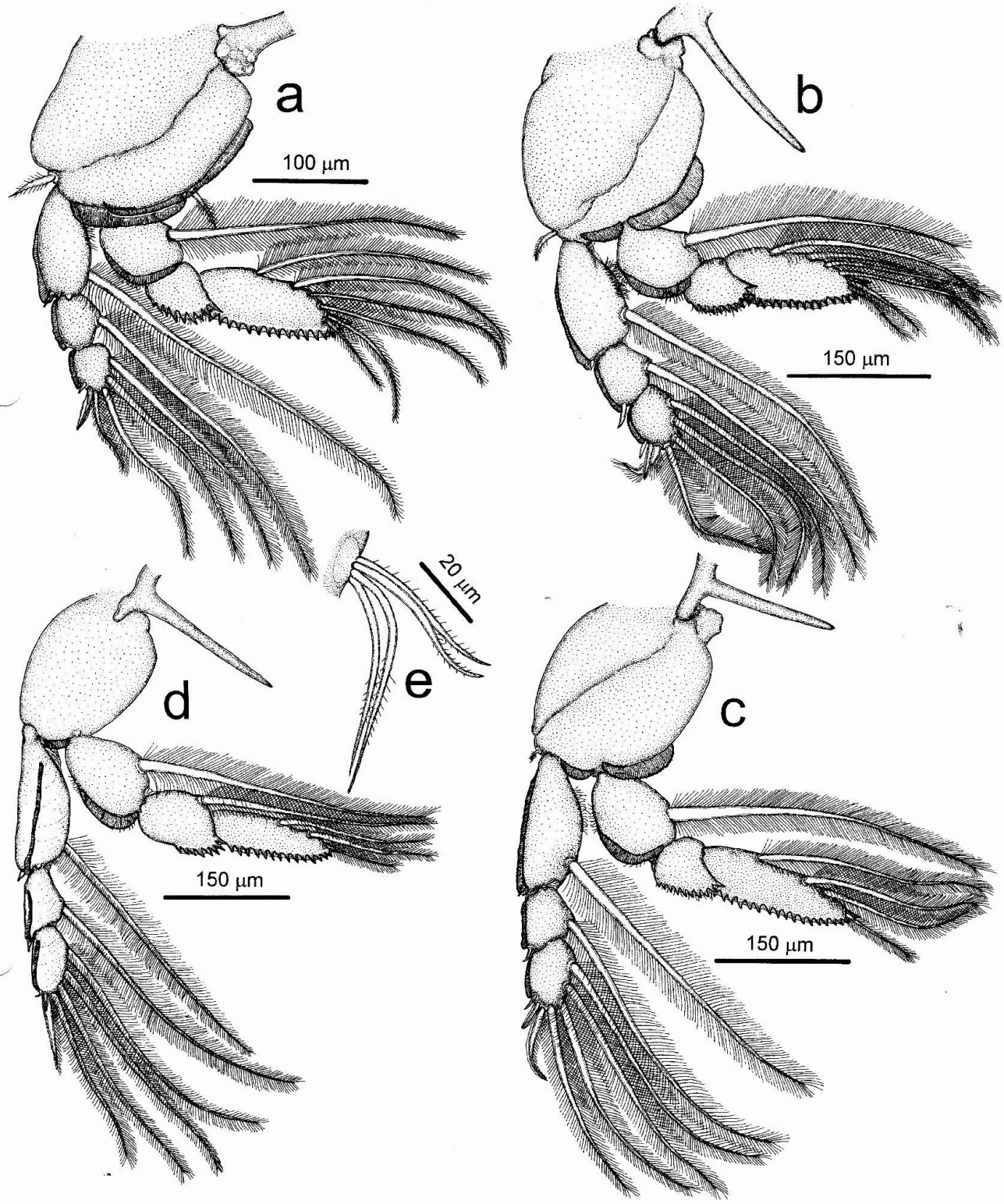


**Fig. 3**. *Kroyeria deetsi* n.sp., adult female. **a**, Leg 1; **b**, leg 2; **c**, leg 3; **d**, leg 4; **e**, leg 5.

scattered lateral setules, and long medial pinnate seta; second segment with long medial pinnate seta and eight large denticles along lateral border; third segment about twice as long as second segment, with three pinnate setae along medial to apical margin, and 15 large denticles along lateral border (proximalmost and distalmost denticles hardly discernible to see in some views). Exopod of leg 4 (Fig. 3d) similar to exopod of leg 3. Leg 5 (Fig. 3e) vestigial, issued laterally at about mid-length of genital complex, present as two pairs of slender pinnate setae.

*Male* (Figs 4, 5). Overall length of allotype approximately 3.7 mm. General morphology similar

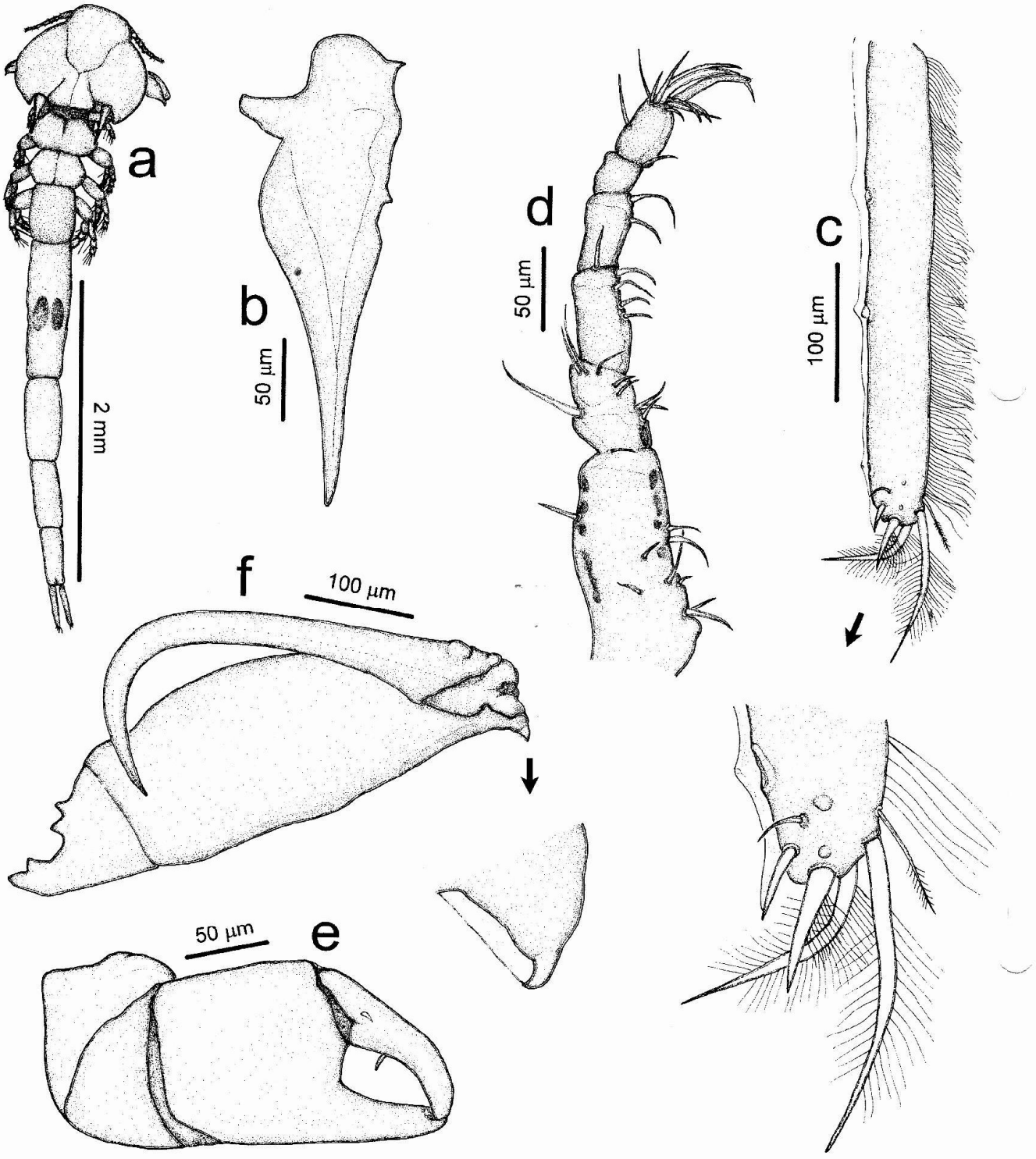


**Fig. 4**. *Kroyeria deetsi* n.sp., adult male. **a**, General habitus, dorsal; **b**, dorsal stylet; **c**, caudal ramus, dorsal, tip enlarged (arrow); **d**, first antenna; **e**, second antenna; **f**, maxilliped, distal portion of corpus maxillipedis enlarged (arrow).

to that of female except notably as follows: entire genital complex comprising about 19% of total body length. Terminal abdominal segment (caudal rami included) slightly longer than second abdominal segment, abdomen about 35 % of total length (Fig. 4a). Dorsal stylets (Fig. 4b) relatively shorter than those of female (*cf.* Figs 1a and 4a), not reaching distal border of first free thoracic segment. Caudal ramus (Fig. 4c) narrower than that of female, with medial fringe of setules, one thin pinnate seta, two pinnate setae, one semi-pinnate seta, one naked seta, one small naked dorsal seta, and several bumps along lateral border. First antenna (Fig. 4d) with seven indistinct segments,

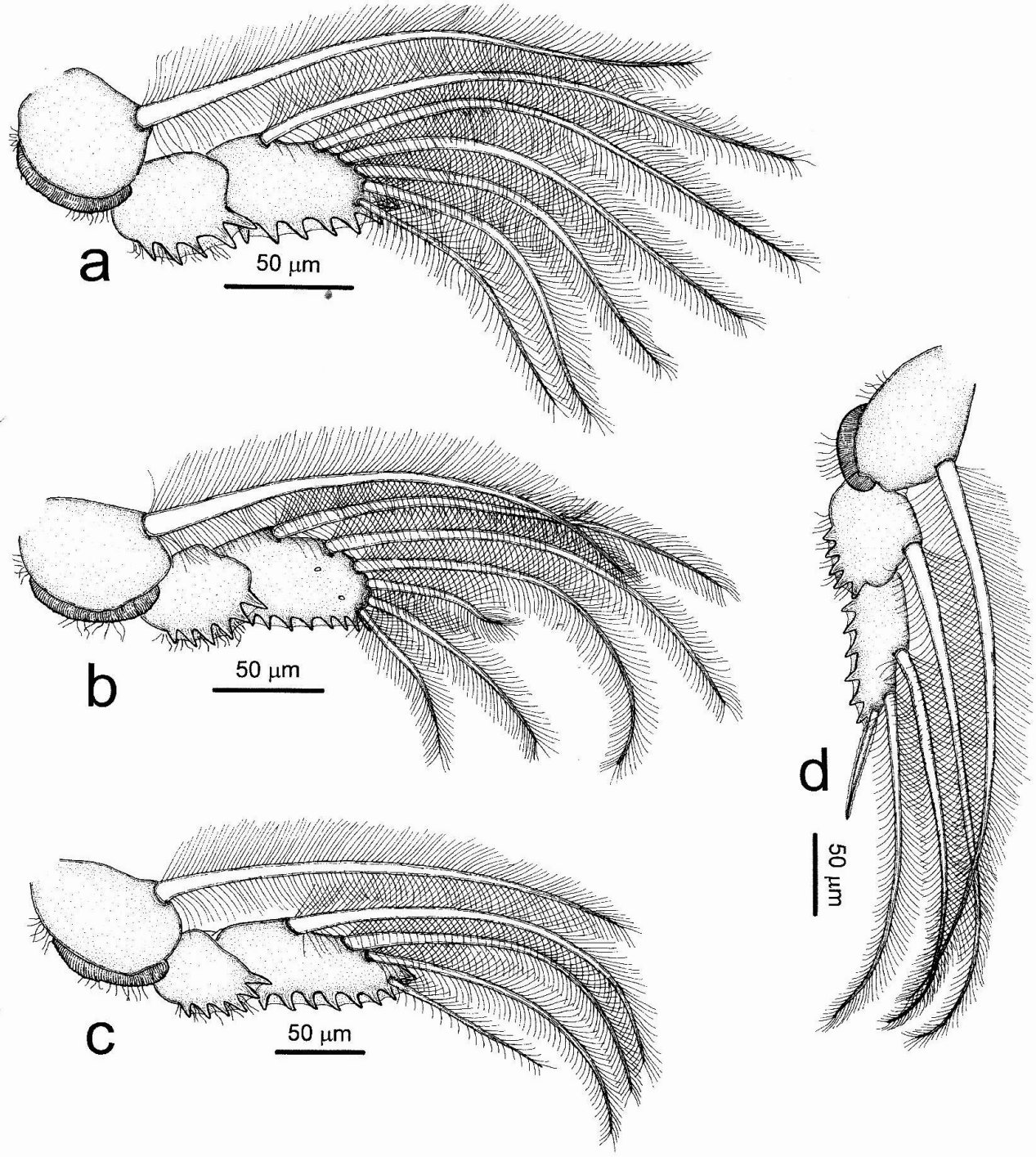


**Fig. 5**. *Kroyeria deetsi* n.sp., adult male. **a**, Leg 1 endopod; **b**, leg 2 endopod; **c**, leg 3 endopod; **d**, leg 4 endopod.

number of seta-like elements observed on segments (base to apex) as follows: 10, 4, 5, 5, 2, 1, 11. Second antenna (Fig. 4e) with two small spiniform setae on fourth segment. Maxilliped (Fig. 4f) with prominent claw-like protuberance on distolateral margin of corpus maxillipedis. Second endopod segments of legs 1–4 with 5, 6, 6 and 5 large denticles, respectively (Figs. 5a–d). Third endopod segments of legs 1–4 relatively shorter than those of female (*cf.* Figs 3a–d with 5a–d), with 7, 8, 9 and 7 large denticles, respectively (proximalmost and distalmost denticles hardly discernible in some views). Terminal segment of leg 2 endopod (Fig. 5b) with short middle seta flanked by longer setae. Terminal segment of leg 4 endopod (Fig. 5d) with two pinnate setae and one short apical seta with lateral membranes. Leg 6 vestigial, consisting of two thin, naked setae which issue laterally from genital complex.

*Host, locality and date of host capture.* Spinner shark, *Carcharhinus brevipinna* (Müller & Henle, 1839) (Carcharhinidae: Carcharhiniformes).

Infected sharks captured in shark nets set by the Natal Sharks Board off the east coast of KwaZulu-Natal, South Africa, as follows: one shark captured off the coast of Glenmore (31°00'S, 29°15'E) during January 1998, and one shark caught off the coast of Uvongo (30°50'S, 29°30'E) during June 1998.

*Specimens collected and infection site.* Eight adult females and two adult males from shark caught off Glenmore and one adult female from shark caught off Uvongo. Copepods were found attached to lamellae of gill filaments or in excurrent water channels between gill filaments.

*Type material.* Types deposited in the National Museum, Cape Town, South Africa (SANM): holotype (female: SANM No. A44000) and allotype (male: SANM No. A44001). Paratypes (all females) retained in the senior author's personal collection.

*Etymology.* The species epithet, *deetsi,* honours Dr Gregory B. Deets for his fine contributions to our understanding of Kroyeriidae.

*Remarks*

The legs of *Kroyeria deetsi* distinguish it from all of its congeners. In particular, the third endopod segments of legs 1–4 of *K. deetsi* are twice (legs 1, 2 and 4) or more than twice (leg 3) as long as the corresponding second endopod segments in the female. Among other kroyerids, *Kroyeria procerobscena* Deets, 1994, and *K. spatulata* Pearse, 1948, have fairly long third segments on the endopods of their legs (Deets 1994); however, they do not appear extraordinarily long as do those of *K. deetsi.* In addition, *K. deetsi* has more third segment endopodal denticles on legs 1–4 than any congener with the exception of legs 1 and 2 of *K. gemursa* (Cressey 1967). However, the denticles on legs 1 and 2 of *K. gemursa* are very small (Deets 1994) compared to those of *K. deetsi.*

Like all members of *Kroyeria* (e.g. Benz & Dupre 1987; Deets 1994), except the mesoparasitic species *K. caseyi* (Benz & Deets 1986), *K. deetsi* attaches to the gill filament lamellae and in the excurrent water channels between gill filaments of its host. Given that the spinner shark occurs widely throughout the Atlantic, Indian and Pacific Oceans (Compagno 1984), it is likely that *K. deetsi* will eventually be reported from other regions.

## ACKNOWLEDGEMENTS

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