

## Two new species of Prosopistomatidae (Ephemeroptera) from South Africa and Swaziland

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Three species of *Prosopistoma* Latreille, 1833 are currently described from Africa. The immature nymph of *Prosopistoma deguernei* Vayssi  re, 1893 was described from Senegal, and the nymph and winged stages of *Prosopistoma africanum* Gillies, 1954 are known from Tanzania. The southern African species *Prosopistoma crassi* Gillies, 1954, initially described as a nymph from KwaZulu-Natal, South Africa, has subsequently been collected in a number of South African rivers. Two further species from South Africa are described here, the nymph of *Prosopistoma amanzamnyama* sp. n., and the nymph and female subimago of *Prosopistoma mccaffertyi* sp. n.

**Key words:** Ephemeroptera, Prosopistomatidae, *Prosopistoma*, systematics, new species, morphology, Africa.

### INTRODUCTION

The first species of Prosopistomatidae described in Africa was *Prosopistoma deguernei*, Vayssi  re, 1893, based on an immature nymph from Senegal. Sixty-one years later, Gillies (1954) described the nymph and winged stages of *P. africanum* from Tanzania and the nymph of *P. crassi* from South Africa. It has taken another fifty-six years for further species to be described in Africa. Two new species from South Africa and Swaziland are introduced here. One of these species, *Prosopistoma mccaffertyi* sp. n., is found in several rivers in the Kruger National Park and rivers in Mpumalanga and Limpopo provinces which flow into the Park, and the distribution extends into Swaziland. The second, *Prosopistoma amanzamnyama* sp. n., is currently known only from the province of KwaZulu-Natal.

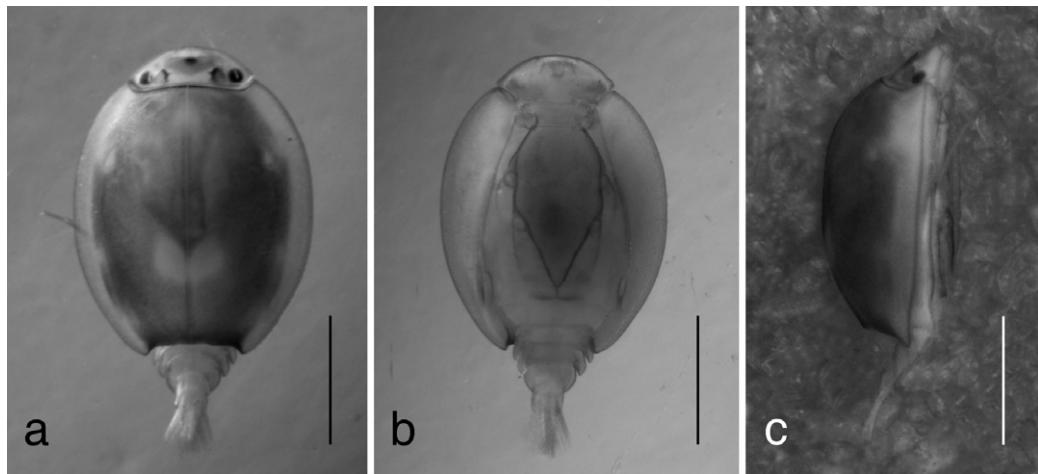
### MATERIAL AND METHODS

Most of the material used for the description of *Prosopistoma mccaffertyi* sp. n. was collected from rivers in the Kruger National Park in October 1990. The nymphs were always found clinging to the underside of large rocks and boulders, often on a bedrock substrate, and were picked off with forceps and placed directly into tubes of 80 % ethanol. Although a range of instars was evident, some of the nymphs were mature, and emergence occurred

at dawn, when female subimagos were collected at light traps at two sites. This collecting was part of a general invertebrate collecting survey carried out in 1990 with W.P. McCafferty from Purdue University, West Lafayette, Indiana, USA, and staff of the Albany Museum, Grahamstown, South Africa. Nymphal material of this species was also collected by the staff of National Institute for Water Research (NIWR) (now Council for Scientific and Industrial Research) during survey work of rivers in South Africa during the late 1950s and early 1960s; this material is now housed at the Albany Museum.

*Prosopistoma amanzamnyama* sp. n. was collected during recent survey work carried out by Mark Graham and associates of Ground Truth – Bio-monitoring Services and Environmental Consultants, Hilton, South Africa. Examination of material in the Albany Museum collection showed that the species was also collected by NIWR staff in 1959.

For dissection and detailed microscopic examination, specimens stored in 70–80 % ethanol were transferred to Cellosolve prior to dissection. Body parts were mounted permanently on standard glass slides in Euparal, transferred directly from the Cellosolve to avoid formation of opaque patches thus avoiding dehydration in ethanol. These were covered with a small glass coverslip and oven-dried at around 50 °C for 24 hours. Mounted struc-



**Fig. 1.** *Prosopistoma amanzamnyama*, mature nymph. **a**, Dorsal view; **b**, ventral view; **c**, lateral view. Scale bars = 1 mm.

tures were examined under a Leica DM 1000 compound microscope and photographed using a Canon Powershot S70 digital camera. Drawings were prepared as described by Barber-James (in press). Further close comparisons were made with the mounted specimens during the drawing process. The gills of both species, and wings of *P. mccaffertyi* sp. n. were prepared as described by Barber-James (in press). Measurements were done from calibrated digital images using the freeware program 'ImageJ'. All counts, measurements and ratio ranges given are for mature nymphs only.

Scanning electron microscopy (SEM) was carried out on a whole nymph of *P. mccaffertyi* to examine the scale-like structures of the sternum more closely, as they are more pronounced in this species than in any others examined to date. The material was dehydrated in an alcohol series, critical-point dried and mounted on a stub, coated with gold and viewed under a Tescan Vega scanning electron microscope. There was not enough material of *P. amanzamnyama* at the time to do the same for this species.

Specimens examined for this study are deposited in the Albany Museum, Grahamstown, South Africa (AMGS), and the Purdue University Entomological Research Collection, West Lafayette, Indiana, USA (PERC). Terminology used in descriptions follows Barber-James (in press), with wing venation following the notation of Kukalová-Peck (1983). All material is in 80 % ethanol unless otherwise stated; institutional catalogue numbers are provided.

## TAXONOMY

### *Prosopistoma amanzamnyama* sp. n.

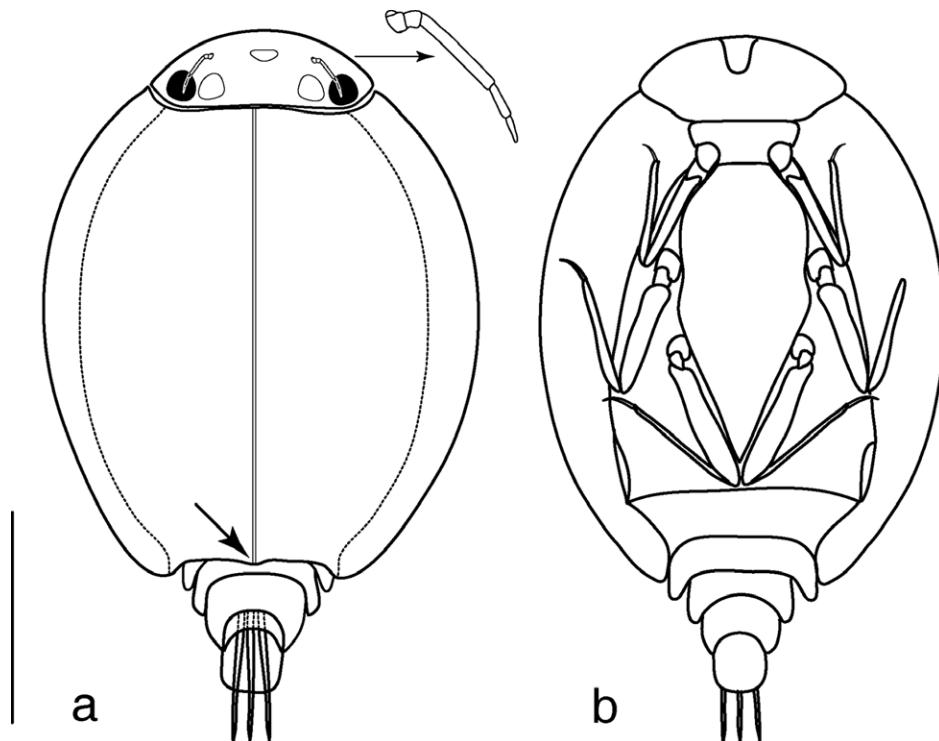
Figs 1–6, 13, 18, Table 1

*Type material.* Holotype, 1 final instar nymph, SOUTH AFRICA, KwaZulu-Natal, aManzamnyama River, 30°36'02"S 29°44'37"E, stones-in-current biotope, 17.xi.2005, Mark Graham (AMGS, GEN 1841B). Paratypes, 1 final instar nymph on slide and 3 nymphs, same data.

*Additional material.* 1 nymph on slide and 1 nymph, Krom River, between Zwartberg and St. Bernhard's Peak, 30°06'15"S 29°11'15"E, 17.xi.1959, staff of National Institute for Water Research NIWR (now CSIR) (AMGS, GEN 355C); 1 nymph, Hlatikulu Vlei, 29°14'15"S 29°47'05"E, 15.ix.2005, Mark Graham (AMGS, GEN 1840B); 1 nymph, Weza River, 30°36'21.62"S 29°45'20.43"E, stones-in-current biotope, 01.iv.2009, Mark Graham, (AMGS, GEN 1863A); 9 nymphs, not fully mature, Ngwangwane River, 29°57'18.72"S 29°31'19.2"E, 01.ix.2009, Mark Graham (AMGS, GEN 1866A).

### Description

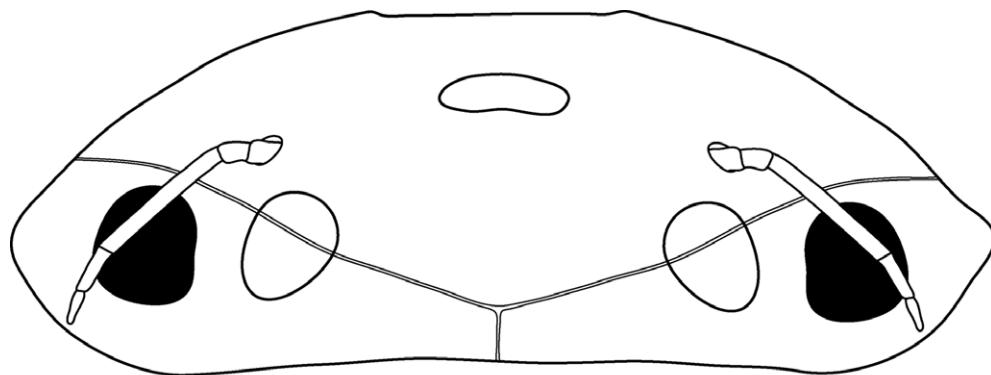
*Mature nymph* (Figs 1, 2). Maximum total length 3.2 mm, excluding caudal filaments. Carapace approximately 1.1 times longer than wide. Cuticle of carapace finely pitted. Carapace with small, insignificant flange (Fig. 2a), distal end of carapace protruding over exhalent notch (arrowed in Fig. 2a). In lateral view, carapace seen to be strongly convex (Fig. 1c); convexity (ratio of maxi-



**Fig. 2.** *Prosopistoma amanzamnyama*, whole nymph. **a**, Dorsal view, with enlargement of left antenna, and protrusion over exhalent notch arrowed; **b**, ventral view. Scale bar = 1 mm.

mum carapace height to length along posterior margin of carapace) for holotype of *P. amanzamnyama* sp. n. is 0.37. Sternum pitted, with rugous, scale-like appearance within the triangular sternal plate, or 'plastron' region (*sensu* Lafon 1952) (Fig. 13a,c).

General colouration light brown, paler around edges of carapace along flange, and with a truncated, pale-cream marking on either side of the midline, two-thirds of the distance along the carapace from the base of the head (Fig. 1a). Head dorsally with a triangular, brown marking encom-



**Fig. 3.** *Prosopistoma amanzamnyama*, dorsal surface of the head capsule of mature nymph, as seen flattened under a compound microscope preparation. The epicranial sutures separate the posterior vertex, which is divided into two parts, from the anterior frontoclypeus. Scale bar = 0.5 mm.

passing median ocellus. Lateral width of head 3 times length from base of labrum to back of occiput. Head width approximately 0.5 times carapace width. Antennae (Figs 2a, 3) longer than distance to anterior margin of head; five-segmented, segment III longer than combined length of remaining segments IV and V. Epicranial sutures evident, passing through lateral ocelli, and between compound eyes and antennal bases, continuing to lateral margin of head. (Fig. 3).

**Mouthparts.** Outer canines of mandibles (Fig. 4a-d) with three apical teeth, middle tooth slightly shorter than teeth on either side, inner margin of outer canine with up to five small teeth below apex. Inner canine shorter than outer; narrow, with two subequal apical teeth, three to four small teeth below apex on inner margin, and two small teeth on outer margin. Three long setae arise from base of inner canine, proximal seta slightly shorter than the two more distal setae, all setae with very mild serrations along inner margins. A single long, simple, unserrated seta arises from the middle of the outer border of the mandible, typical of Prosopistomatidae. Ten to 12 setae and/or setal sockets form a field medially to basally on mandible (Fig. 4a,b,e). Right mandible with two small teeth on the outer margin of the outer canine (Fig 4c), not evident on left mandible; otherwise left (Fig. 4b) and right mandible (Fig. 4a) similar.

Maxillae (Fig. 4f) crowned by rigid canine and three moveable dentisetae (*sensu* Kluge 2004), the canine and dentisetae subequal in length to each other; two or three stout, mildly serrated setae arise near base of canine and dentisetae. Short, single seta present near base of sclerotized section of galea-lacinia. Maxillary palp three-segmented, segment II 1.3 times as long as segment I, segment III 0.4 times as long as segment II. Palp extending beyond the notch which marks the separation between the stipes and galea-lacinia.

Hypopharynx (Fig. 4g,h) composed of dorsal lingua, with striations running on inner surface of lingua from anterior to posterior; superlinguae fused to form ventral part, interior surface with cushion of fine setae. Hypopharynx structure in Prosopistomatidae is discussed in greater detail in Barber-James (in press).

Labrum (Fig. 4i) densely pitted, anterior margin fringed with simple setae. Labium (Fig. 4j) typical of Prosopistomatidae, consisting of fused prementum composed of fused glossae and paraglossae, recessed in greatly expanded postmentum

(Barber-James, in press); scale-like structures present along basal margin of postmentum, otherwise with scattered pits forming the base of small setae; margin fringed with dense setae. Labial palp segment II 0.65 times length of segment I, segment III 0.7 times length of segment II.

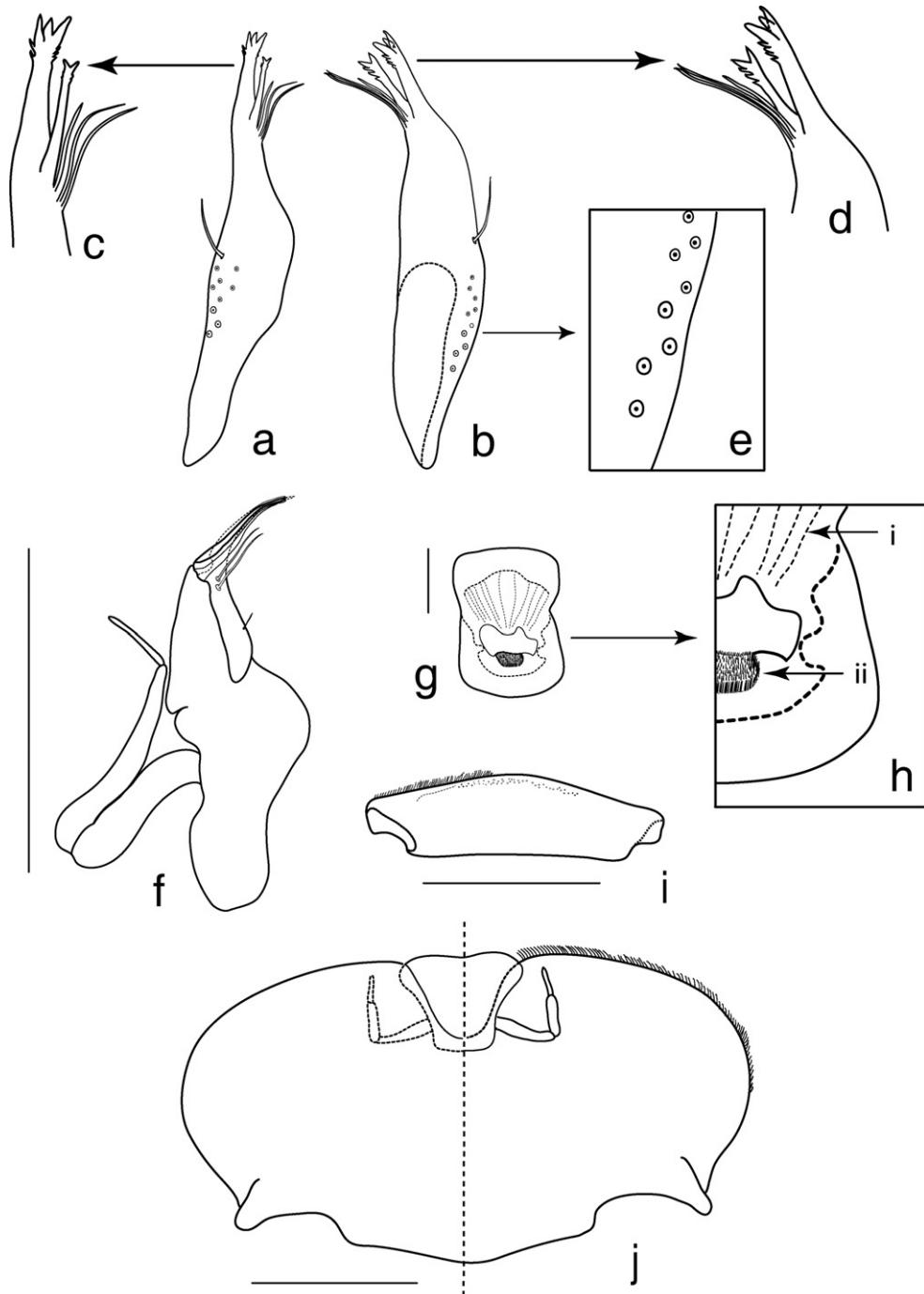
**Legs** (Fig. 6). Dorsal margin of femora with 8–10 relatively stout, simple setae; ventral margin of fore-tibia with up to 10–11 setae with inner margins of setae pectinate. Anterior and posterior surface of coxa and femur with dense scale-like covering (Fig. 6b).

**Abdomen.** Abdominal gills (Fig. 5a–f); Gill I (Fig. 5a) with lamellate upper portion, margin serrated, lower portion highly divided into filaments, many of which branch dichotomously; 7–9 filaments present, counted at their base and not including bifurcations. Gill II (Fig. 5b) expanded to form broad lamella, which covers remaining gills except for gill VI; gills III–V (Fig. 5c–e) with numerous, mostly dichotomously branching filaments; gill VI (Fig. 5f) conical in shape. Postero-lateral projections of abdominal segments VII–IX blunt-ended (Figs 1a,b, 2a,b). Sternal plate (Fig. 13a,c) densely covered with small, scale-like structures. Caudal filaments small, fringed with dense setae, retractile as in all *Prosopistoma* species. No gender differences were evident between nymphs.

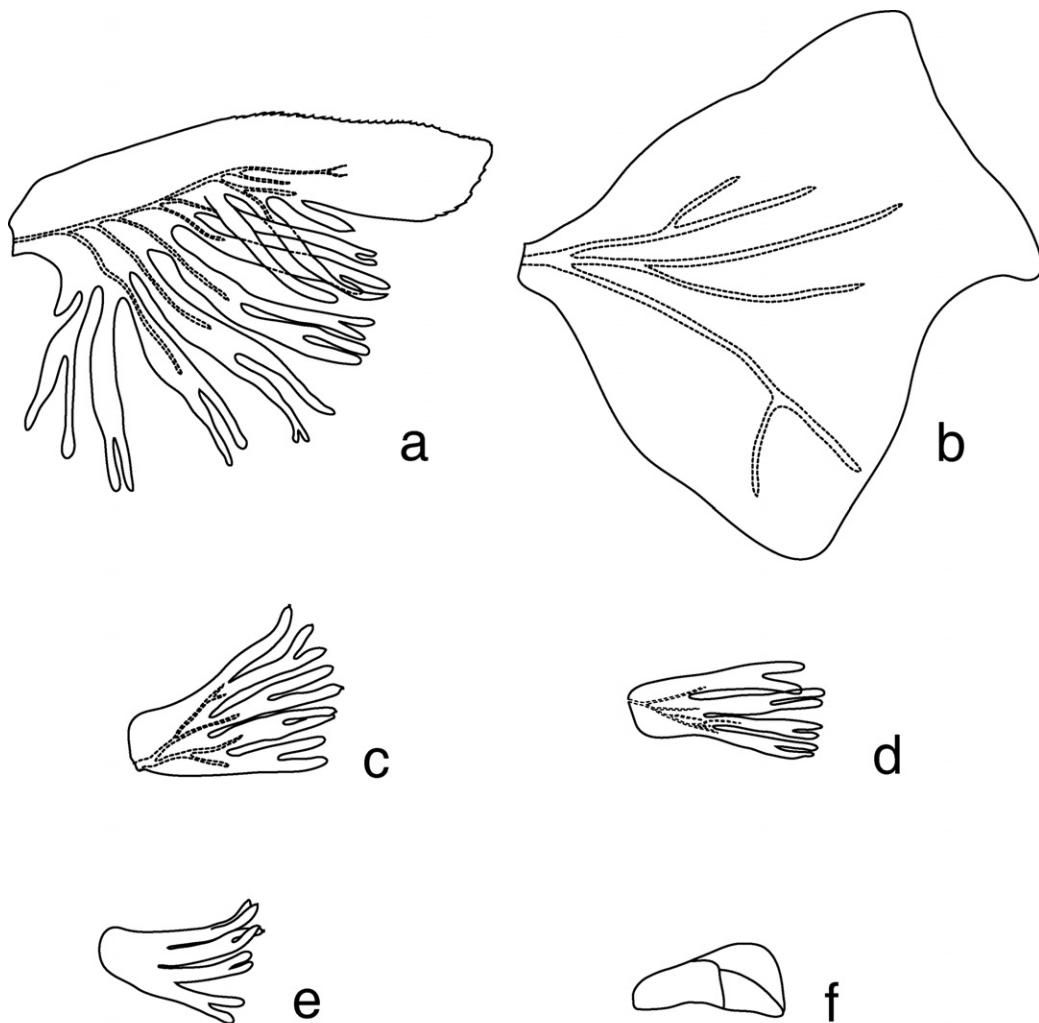
**Diagnosis.** The nymphs of *P. amanzamnyama* can be told apart from other African species by the combination of characters and comparative ratios indicated in Table 1. At a glance, *P. amanzamnyama* can be told apart from *P. crassi* by having a much narrower flange around the carapace than *P. crassi* does, and by being more dome-shaped compare to the flatter disc-shaped *P. crassi*. The immature nymph of *P. deguernei* described by Vayssi  re (1893) is shown to have longer antennae which extend over the margin of the head for about half their length; *P. deguernei* is noted to have a markedly scaly cuticle, and the length of the carapace is two-thirds of the width. It is difficult to compare *P. deguernei* realistically with the other African species as the description was evidently based on a young instar, and fresh material is needed from Senegal.

**Distribution.** See Fig. 18. *Prosopistoma amanzamnyama* species occurs within the distribution range of *P. crassi*, although to date they have not been found to be sympatric.

**Etymology.** Named after the first river from



**Fig. 4.** *Prosopistoma amanzamnyama*, mouthparts of mature nymph. **a**, Right mandible, dorsal view; **b**, left mandible, ventral view; **c**, apex of right mandible enlarged; **d**, apex of left mandible enlarged; **e**, margin of middle section of mandible enlarged to show field of small setal bases and setae; **f**, right maxilla; **g**, hypopharynx, viewed from anterior end, looking through to the opening connecting with the pharynx posteriorly; **h**, portion of hypopharynx enlarged, showing striations running down interior of lingua (arrow i), patch of setae mediobasally in superlinguae (arrow ii); **i**, labrum; **j**, labium within expanded postmentum, left ventral, right dorsal. Scale bars = 0.25 mm.



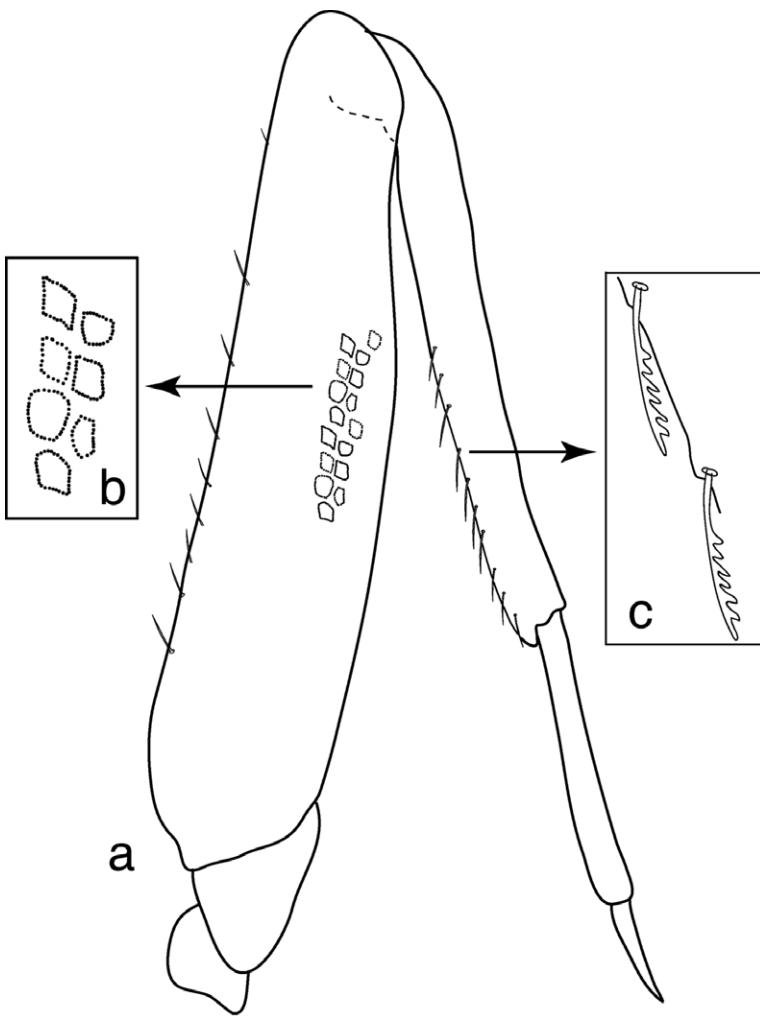
**Fig. 5.** *Prosopistoma amanzamnyama*, nymphal gills. **a**, Gill I, showing serrated margin of lamellate portion; **b**, gill II; **c**, gill III; **d**, gill IV; **e**, gill V; **f**, gill VI. Scale bar = 0.25 mm.

which this species was recognized as a new species, the aManzamnyama River, meaning 'dark water' in the Zulu language, after the black doleritic rocks in the riverbed.

*Comment on ecology.* It is well documented that Prosopistomatidae are sensitive to pollution (e.g. Barber-James 2003; Zhou & Zheng 2004; Schletterer & Füreder 2009). Surveys of the aManzamnyama and Weza Rivers (Graham 2003) show these rivers to be in a 'natural' condition, which needs to be preserved in order for this species to continue to prosper. The nymphs of this species were collected from stones in fast-flowing stretches of river. Water temperature ranged from

14.5 to 25.9 °C, pH from 6.7 to 7.2.

Dissection and dispersion of stomach contents onto glass slides, and subsequent microscopic examination revealed the presence of detritus-like matter in the gut of *P. amanzamnyama*. All prosopistomatid nymphs have specialized mouthparts; the mandibles have no molar regions and well-developed incisors, the maxillae have a long canine and dentisetae, which would imply carnivory. This mouthpart structure has lead several people to believe that Prosopistomatidae nymphs are primarily carnivorous (Trägårdh 1911; Kluge 2004). However, Fontaine (1980) found that only some of the species she investigated had insect



**Fig. 6.** *Prosopistoma amanzamnyama*, foreleg of nymph. **a**, Whole leg, lateral view; **b**, enlargement of section of scale pattern, which covers the entire surface of coxa and femur; **c**, enlargement of part of tibia to show pectinate setae along inner margin. Scale bar = 0.5 mm.

remains in their gut, while others had algae or diatoms. She pointed out that one cannot assume a mode of behaviour based on morphology alone. *P. amanzamnyama* is clearly not a carnivorous species.

#### ***Prosopistoma mccaffertyi* sp. n., Figs 7–18,**

##### **Table 1**

*Type material.* Holotype, 1 final instar nymph, SOUTH AFRICA, Mpumalanga, Sabie River at Lisbon Estates, 24°59'10"S 31°27'05"E, stones-in-current biotope, 27.x.1990, H.M. Barber and W.P. McCafferty (AMGS, LIM 17L). Paratypes, 1 final

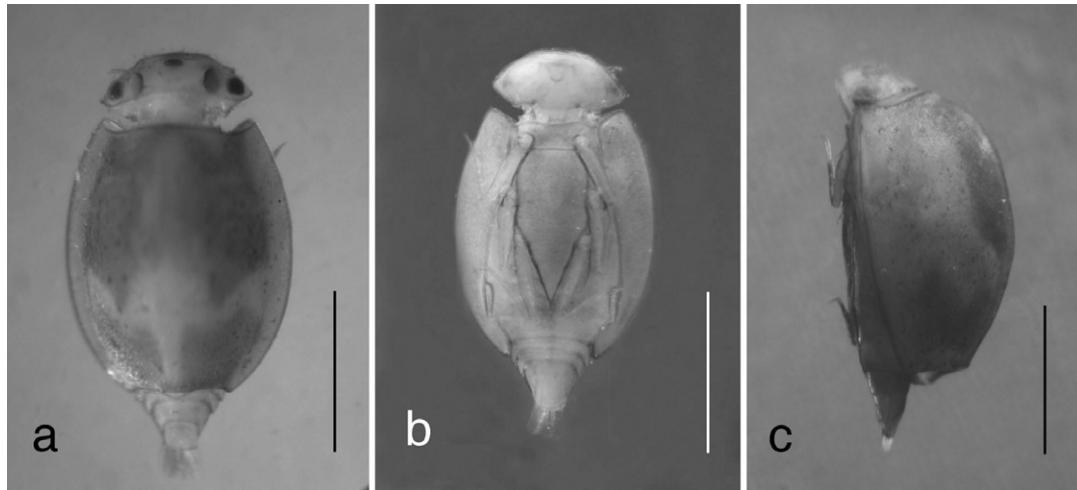
instar nymph on slide (PERC, SA40); 10 nymphs (5 specimens PERC, SA40; 5 specimens AMGS, LIM 17L); one female subimago caught at pre-dawn light trap (PERC, SA40a), same data.

*Additional material.* Six female subimagos, Sabie River, Kruger National Park, 7 km north of Skukuza near gauging weir, 24°58'35"S 30°35'05"E, 23.x.1990. Collectors W.P. and N. McCafferty, F.C. de Moor and H.M. Barber (4 specimens PERC, SA 35A; 2 specimens AMGS, LIM 31T). 1 nymph, Sabie River, Kruger National Park, 7km north of Skukuza, 24°58'35"S 31°35'05"E, 24.x.1990,

**Table 1.** Summary of key diagnostic characters for African *Prosopistoma* species (excluding *P. deguernei*).

	<i>P. africanum</i> *	<i>P. amanzamnyama</i>	<i>P. crassum</i> *	<i>P. mcaffertyi</i>
Total body length of nymph (♂ or ♀ specified where possible)	♂ 2.8–3.0 mm* ♀ 3.5–4.0 mm*	2.8–3.2 mm (n = 5)	4.6–5.5 mm (n = 15)	2.12–2.3 mm (n = 6)
No. of pectinate spines on foretibia	5–8	10–11	8–10	5–6
No. of antennal segments incl. scape and pedicel	6	5	6	5
Antenna reaching beyond / not reaching anterior margin of head	Reaching beyond	Not reaching	Not reaching	Not reaching
Antenna with segment III longer / shorter / subequal to remaining segments	Shorter	Longer	Subequal	Longer
No. of major filaments branching off gill I of mature nymph (increases with age)	8–10 (n = 2)	8–9 (n = 4)	8–10 (n = 10)	7–9 (n = 4)
Carapace flange wide/narrow	Narrow	Narrow	Wide	Narrow
Distal end of carapace with incised / protruding notch	Protruding notch	Protruding notch	Incised notch	Incised notch
Ratio length of carapace (along median suture):width	1.00–1.10 (n = 2)	1.05–1.08 (n = 5)	0.75–0.88 (n = 15)	1.11–1.16 (n = 6)
Ratio head width:carapace width	0.6	0.5	0.5	0.55–0.63 (n = 6)
Ratio dist between eyes: maximum head width	0.7	0.8	0.7	0.75–0.84 (n = 6)
No. of setae / setal sockets at rear end of mandible	5 (n = 2)	10–12 (n = 4)	9–15 (n = 10)	10–12 (n = 4)
Convexity: carapace depth:length	0.5 (n = 2)	0.36–0.40 (n = 5)	0.27–0.30 (n = 15)	0.42–0.46 (n = 6)
Sternal plate	Very small, fine, scale-like structures, sparsely scattered	Small, scale-like structures, densely covering sternal plate	Small, scale-like structures, densely covering sternal plate	Scale-like structures relatively large, densely covering sternal plate
Total body length in female subimago (excl. caudal filaments)	3.6 mm*	Unknown	Unknown	2.1–2.7 mm (n = 7)
Forewing length in female subimago	4.5 mm*	Unknown	Unknown	3.3–3.8 mm (n = 7)

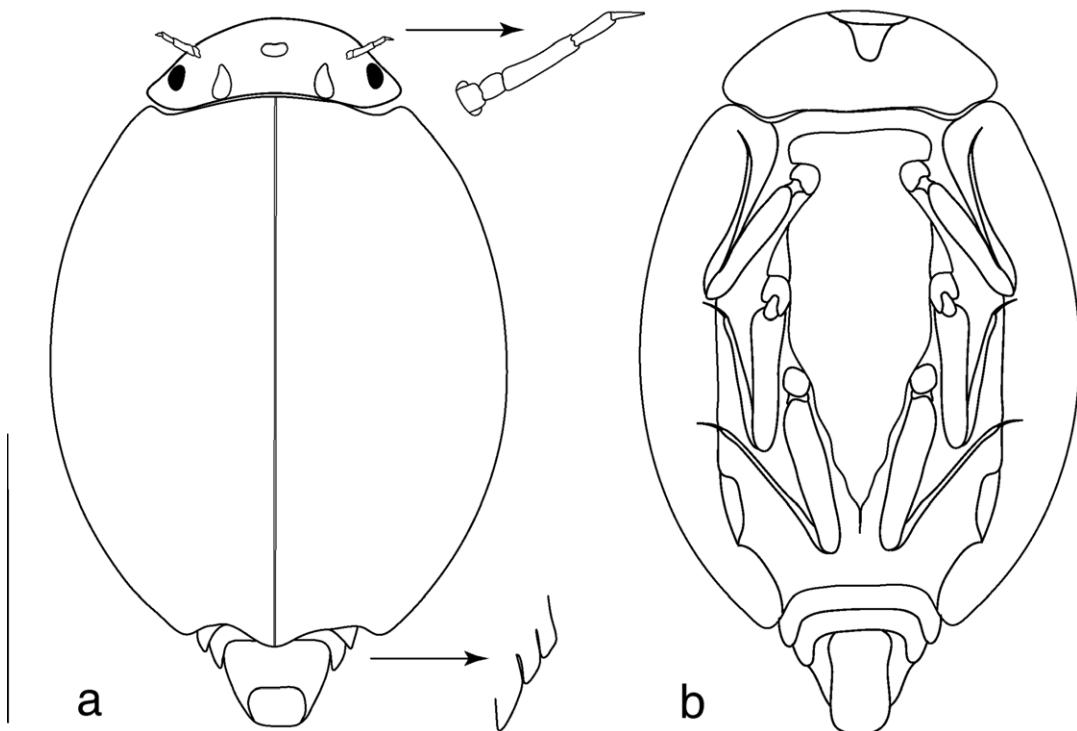
\*Source: either Gillies (1954) or personal measurements.



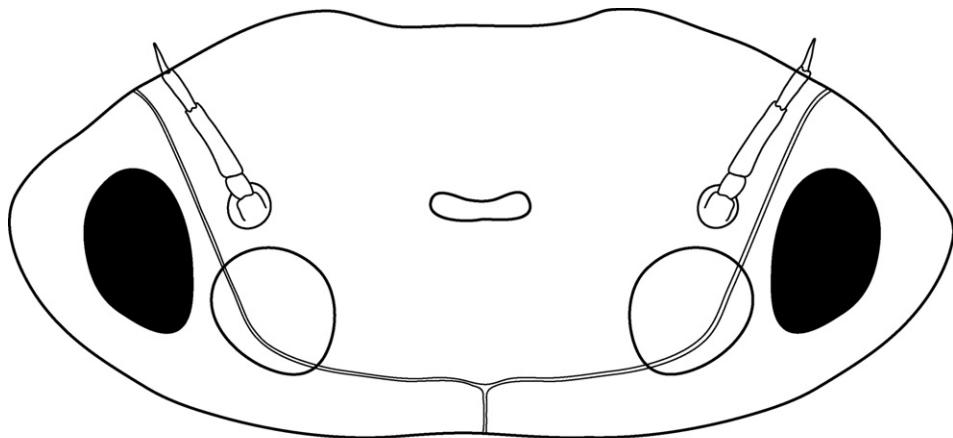
**Fig. 7.** *Prosopistoma mccaffertyi*, mature nymph. **a**, Dorsal view; **b**, ventral view; **c**, lateral view. Scale bars = 1 mm.

stones-in-current biotope, H.M. Barber and W.P. McCafferty, (AMGS, LIM 29K). 9 nymphs, various instars; 1 mature nymph on slide, Crocodile River, near Nelspruit, 25°27'00"S 30°56'45"E, 07.vii.1959, staff of National Institute for Water Research

(NIWR) (now CSIR), (AMGS, GEN 112H). 1 nymph, Swaziland, Usutu River, 26°35'00"S 31°05'00"E, 13.vii.1961, National Institute for Water Research (NIWR) (now CSIR), (AMGS, GEN 674C). 1 nymph, Swaziland, Usutu River, 1.2 km above Usutu Pulp



**Fig. 8.** *Prosopistoma mccaffertyi*, whole nymph. **a**, Dorsal view, with enlargement of left antenna and posterolateral margin of abdomen; **b**, ventral view, caudal filaments retracted. Scale bar = 1 mm.



**Fig. 9.** *Prosopistoma mccaffertyi*, dorsal view of nymphal head showing epicranial sutures, flattened in microscope preparation. Scale bar = 0.5 mm.

mill, 1981/08/20 26°32'35"S 3°00'10"E, 20.VII.1981, F.C. de Moor, (AMGS, GEN 798G).

#### Description

Mature nymph (Figs 7, 8). Total length of final instar nymph (holotype) 2.3 mm, excluding caudal filaments. Carapace longer than wide, length to width ratio just over 1.1; lateral view (Fig. 7c) shows carapace to be strongly convex (humped), convexity of holotype is 0.46. Cuticle of carapace coarsely pitted, interspersed with scale-like structures. Flange of carapace not pronounced, distal end of carapace protruding slightly over exhalent notch. Sternum pitted, bearing coarse scale-like structures within the triangular sternal plate (Figs 13b,d, 14a-d).

General colouration light brown, paler around edges of carapace and dorsally on head. Distinctive, pale marking on lower third of carapace, forming a broad zig-zag pattern, with expanded M-shape in middle, extending down the midline to the base of the carapace (Fig. 7a). This marking may be less distinct in some individuals. Head dorsally uniform pale cream-brown. Head width 0.6 times carapace width. Width of head of holotype approximately 3.3 times length (from base of labrum to back of head). Antennae longer than distance from antennal base to anterior margin of head; five-segmented, segment III 1.5 times longer than segments IV and V (Figs 8a, 9). Tip of antenna with a narrow, pointed end. Epicranial sutures passing through lateral ocelli,

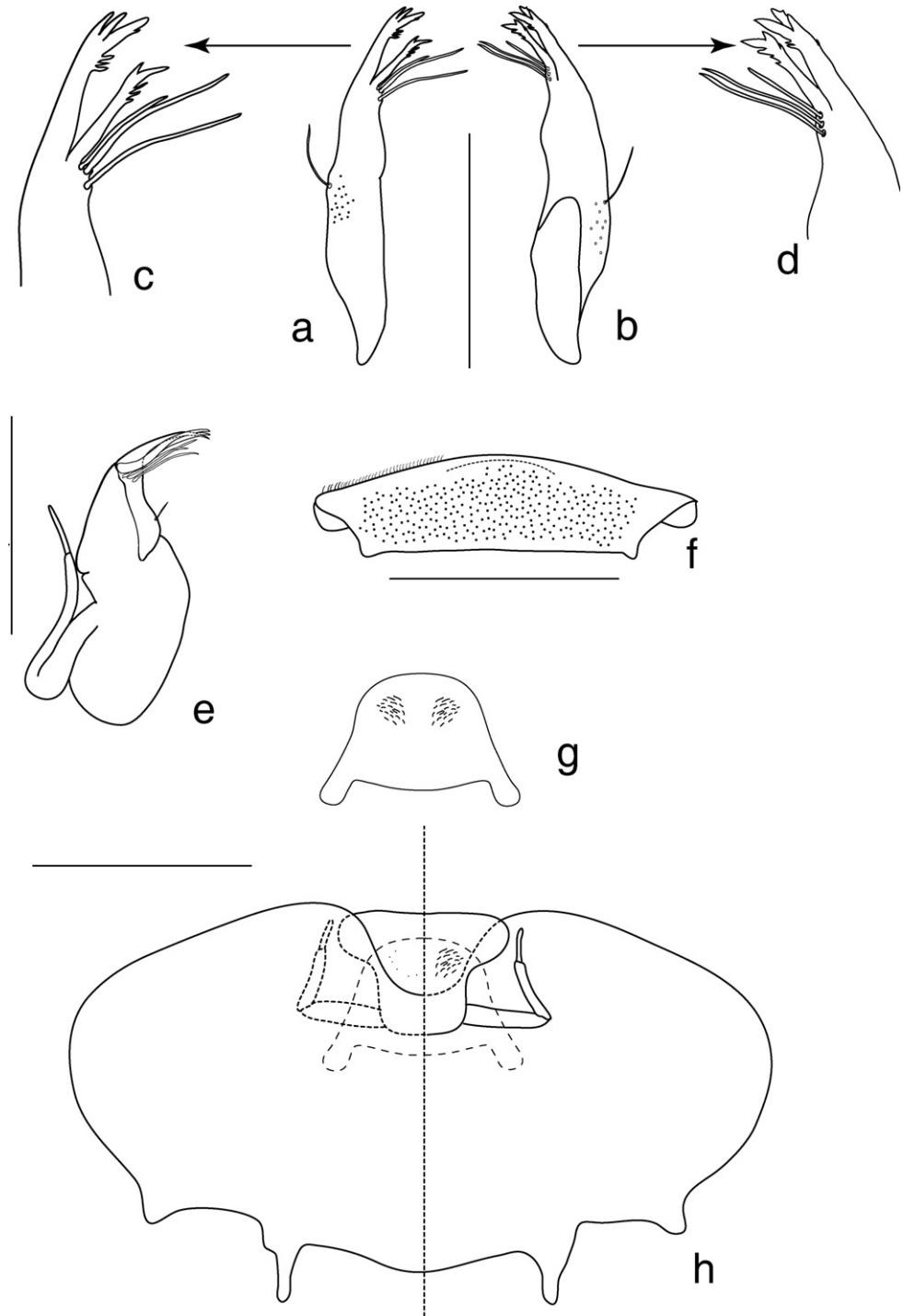
and between compound eyes and antennal bases (Fig. 9).

**Mouthparts.** Outer canine of right mandible (Fig. 10a,c) with three apical teeth, subequal in size, inner margin of outer canine with two to three small teeth below apex. Inner canine shorter and narrower than outer, with two apical teeth of approximately equal size, and three small teeth below apex. Three long, finely serrated setae arise from base of inner canine, the uppermost one shorter than the lower two. Serrations only apparent along distal third of each seta. A single long seta arises from the middle of the outer border of the mandible. Ten to 12 setae and/or setal sockets form a field medially to basally on mandible. Left mandible (Fig. 10b,d) similar to right.

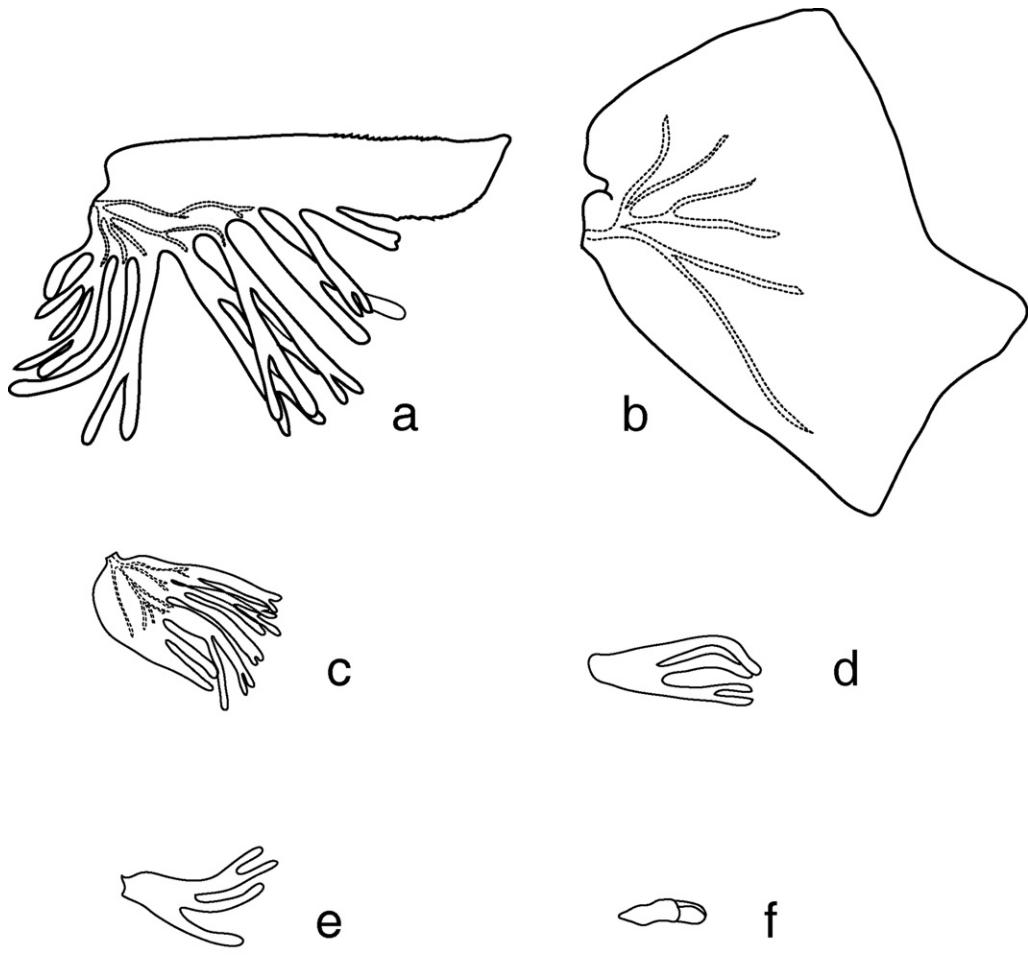
Maxillae (Fig. 10e) crowned by rigid canine and three subequal moveable dentisetae; three simple, stout setae arise near base of canine and dentisetae. Single fine seta present, about two-thirds of way down the sclerotized section of galea-lacinia. Maxillary palp three-segmented, segments I and II approximately equal in length, though segment I is wider; segment I is 0.4 times length of segment II. Palp extending beyond the notch, which marks the separation between the stipes and galea-lacinia.

Hypopharynx (Fig. 10g,h) difficult to see, composed of dorsal lingua and fused superlinguae which form ventral part, interior surface of lingua with patches of fine setae visible on either side.

Labrum (Fig. 10f) with surface pitted, fringed with fine setae. Labium (Fig. 10h) typical of



**Fig. 10.** Mouthparts of mature nymph of *Prosopistoma mccaffertyi*. **a**, Right mandible, dorsal view; **b**, right mandible, ventral view; **c**, apex of right mandible enlarged; **d**, apex of left mandible enlarged; **e**, right maxilla; **f**, labrum; **g**, hypopharynx, ventral view; **h**, labium within expanded postmentum, left ventral, right dorsal, hypopharynx (dotted lines) shown *in situ*. Scale bars = 0.25 mm.



**Fig. 11.** *Prosopistoma mccaffertyi*, nymphal gills. **a**, Gill I; **b**, gill II, apex of lamellate section magnified to show serrated upper and lower margins; **c**, gill I, enlargement of one filament; **d**, gill II; **e**, gill III; **f**, gill IV; **g**, gill V; **h**, gill IV, showing slight serration of margin (arrow). Scale bar = 0.25 mm.

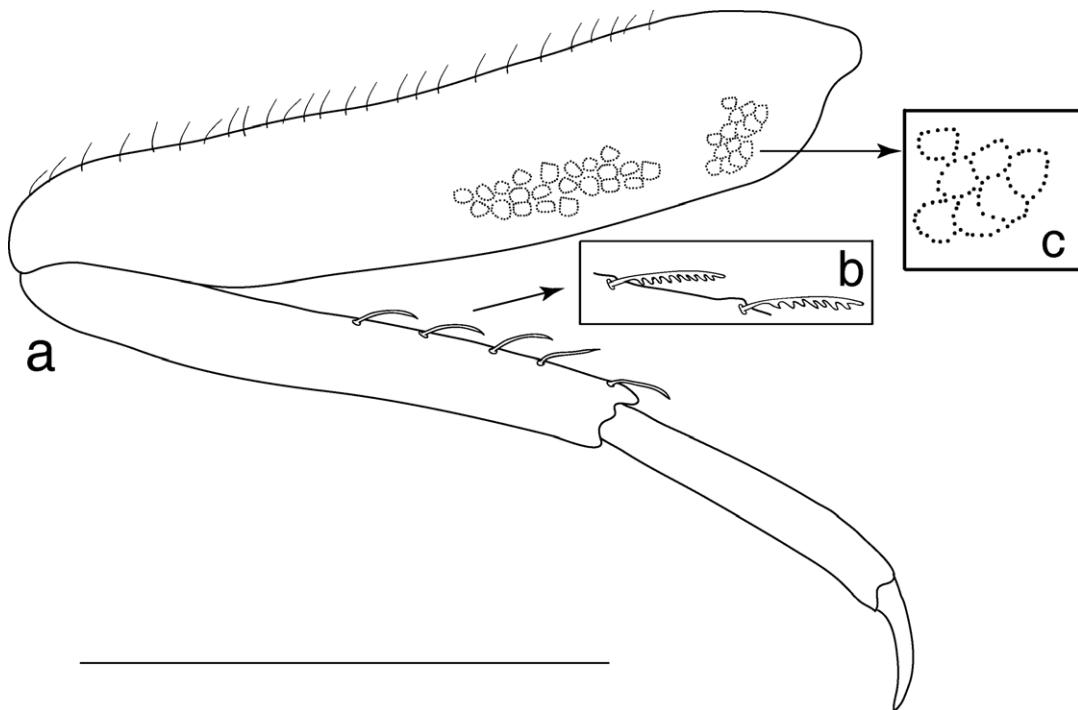
Prosopistomatidae, consisting of fused prementum composed of fused glossae and paraglossae, recessed in greatly expanded postmentum. Ventral surface of postmentum covered with scales and setae. Labial palp segment II 0.8 times length of segment I, segment III 0.5 times length of segment II.

Legs (Fig. 12). Dorsal margin of femora with over 20 relatively fine, simple setae; ventral margin of fore-tibia with 5–6 spines, with inner margins of setae pectinate. Anterior and posterior surface of coxa and femur with reticulate pattern formed by scale-like structures.

**Abdomen.** Abdominal gills (Fig. 11a–f); gill I (Fig. 11a) with lamellate upper portion, margin

finely serrated, lower portion highly divided into filaments, many of which branch dichotomously; 8–9 filaments present, counted at their base and not including bifurcations. Gill II (Fig. 11b) expanded to form broad lamella, which covers remaining gills except for gill VI; gills III–V (Fig. 11c–e) with numerous, mostly dichotomously branching filaments; gill VI (Fig. 11f) minute, conical in shape.

Posterolateral projections of abdominal segments VII–IX broad, truncated (Fig. 8a). Sternal plate rough in appearance and microscopic examination reveals a covering of fine scales-like structures scattered randomly over the surface (Fig. 13b,d). These can be seen in greater detail with



**Fig. 12.** *Prosopistoma mccaffertyi*, foreleg of nymph. **a**, Whole leg, lateral view; **b**, enlargement of pectinate seta near lateral margin of tibia; **c**, section of scale pattern indicated; this covers the entire surface of coxa and femur. Scale bar = 0.5 mm.

SEM (Fig. 14a–d), and vary from being pointed on the ventral surface of the flange (Fig. 14b), to rounded on the sternal plate (Fig. 14d).

Caudal filaments similar to those of *P. amanzamnyama*.

Apart from some nymphs having slightly larger eyes than others, there are no apparent gender differences evident between nymphs, and there is no evidence that this small difference is significant or gender-related.

Female subimago (Figs 15–17).

As is typical in Prosopistomatidae (Vayssi  re 1881; Gillies 1954; Fontaine 1955; Barber-James, in press), the female of *P. mccaffertyi* appears to be sexually mature in the subimaginal stage. Total body length of holotype excluding cerci 2.3 mm; caudal filaments short (0.26 mm). Preserved colouration predominantly dark brown, with last two abdominal segments paler brown to cream; head uniform dark brown, with no other markings. Lateral ocelli white-topped, black around bases, median ocellus black. Thin flange protruding upwards at right angles from posterior margin of head (arrowed in Fig. 17a). Antennae as in Fig. 17b.

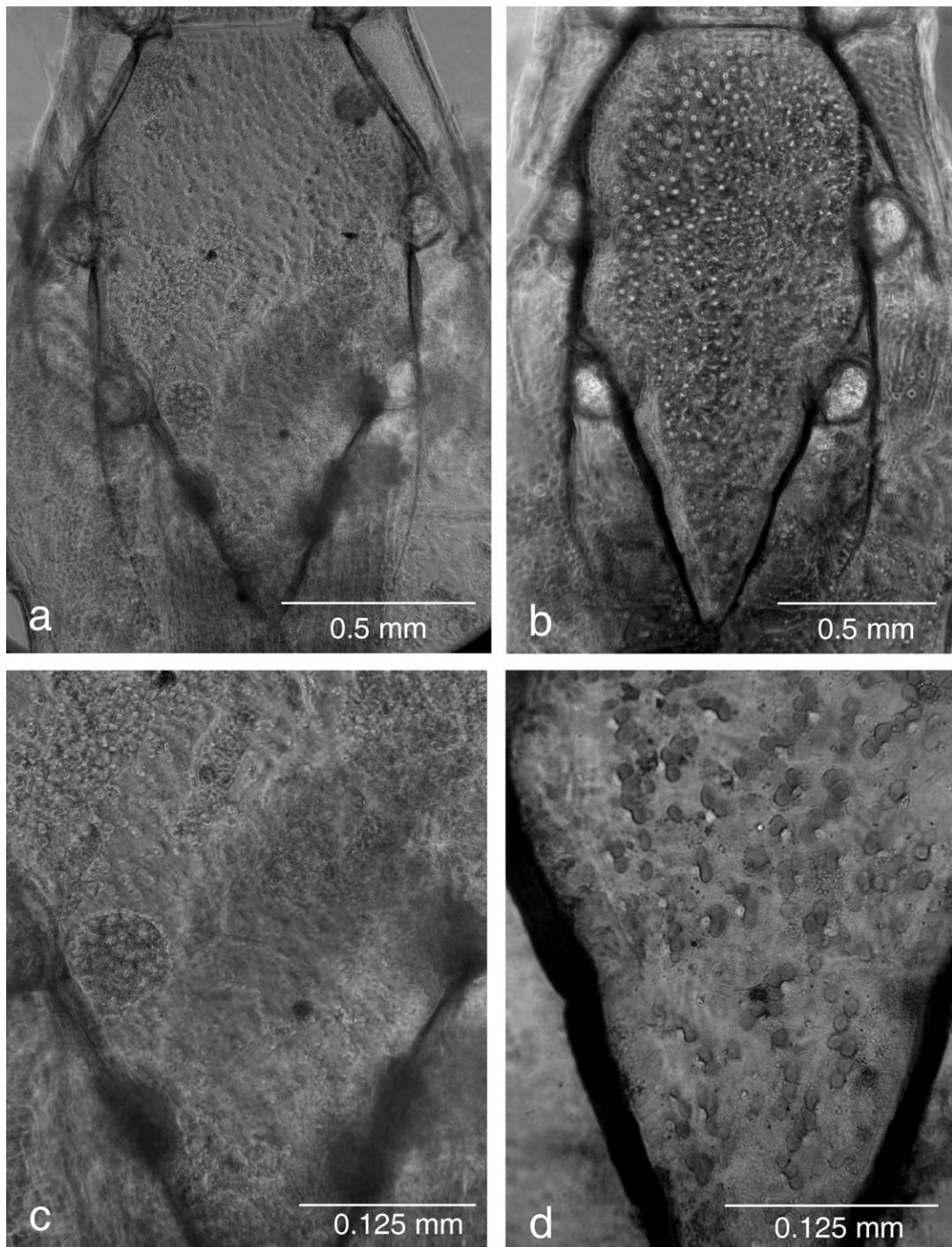
Head width from outer edges of prominent eyes 0.67 mm, head length from posterior margin of clypeus to back of head 0.17 mm. Mouthparts vestigial, only remnant labium and labrum evident.

**Thorax.** Thorax and wing braces dark brown. Forewing of holotype (Fig. 15a) 3.7 mm in length, 1.5 mm at widest point, hindwing (Fig. 15b) 0.9 mm in length. Wing venation (Fig. 15) follows the nomenclature of Kukalov  -Peck (1983). Homology of hindwing venation impossible to derive. Vein RP<sub>1</sub> partially reduced, as seen in *P. africanum*. Further discussion on wing venation in Prosopistomatidae can be seen in Barber-James (in press).

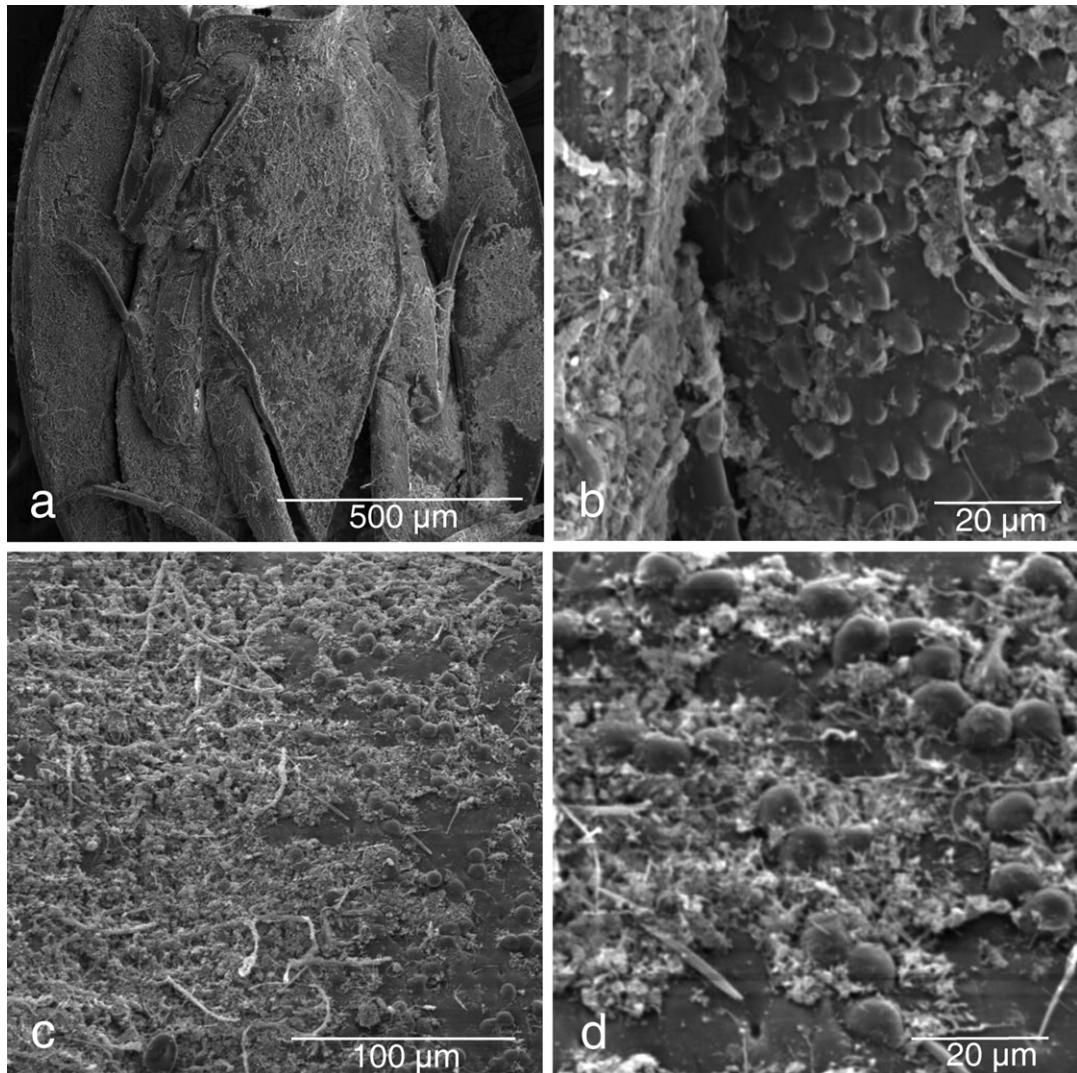
**Legs** (Fig. 16). With developed femora but atrophied tibiae and tarsi.

**Male imago unknown.**

**Diagnosis.** The nymphs of this species can be told apart from other species by the combination of characters and comparative ratios shown in Table 1. In addition, the sternal plate has larger, more pronounced scales than in *P. amanzamnyama*; gill VI is much smaller than in other African species



**Fig. 13.** Light micrographs of sternal plate of nymphs. **a, c,** *Prosopistoma amanzamnyama*, showing finer scale-like structures; **b, d,** *Prosopistoma mccaffertyi* showing coarser scale-like structures.



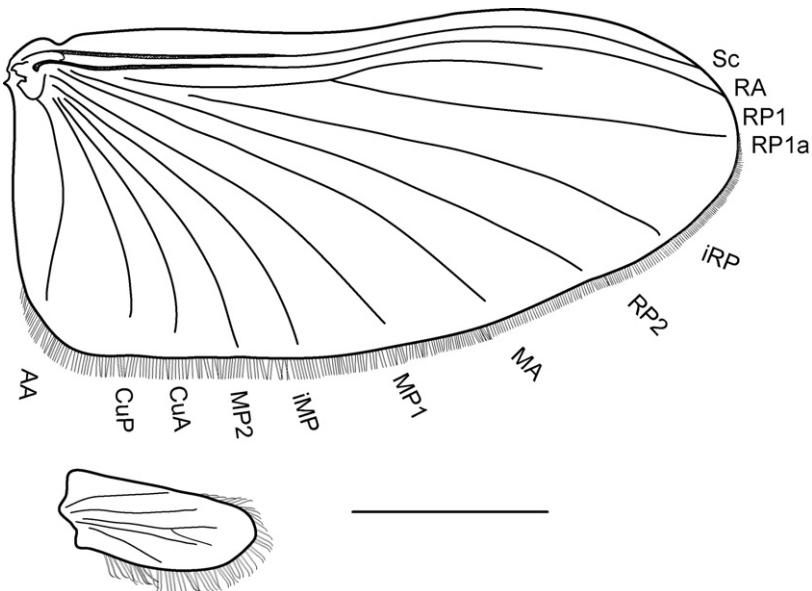
**Fig. 14.** Scanning electron micrographs of ventral surfaces of *Prosopistoma mccaffertyi*. **a**, Sternal plate, legs and ventral surface of lateral flange; **b**, closer view of ventral surface of flange adjacent to foretibia, showing details of scale-like structures on flange; **c**, closer view of surface of sternal plate; **d**, higher magnification showing details of rounded scale-like structures on sternal plate.

described to date. As with *P. amanzamnyama*, *P. mccaffertyi* is more dome-shaped than *P. crassi*. Female subimagoes are very similar to *P. africanum* but can be distinguished by their smaller size (Table 1).

*Distribution* (Fig. 18). *P. mccaffertyi* is geographically separate from *P. amanzamnyama*. However, it occurs within the distribution range of the more widespread *P. crassi*, and at some sites these two species were sympatric (Fig. 18).

*Etymology.* Named after Dr W. Patrick McCafferty (Purdue University, West Lafayette, Indiana, U.S.A.), who first collected this species with me in the Kruger National Park in 1990.

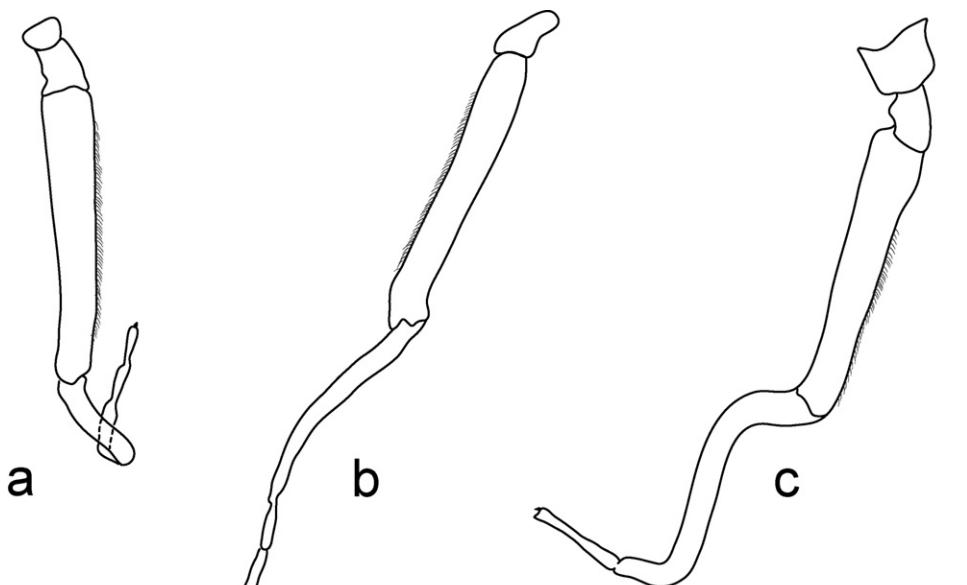
*Comment on ecology.* Nymphs often found with fine scattering of silt-like particles all over carapace, abdomen and head, indicating possibly that the nymphs inhabit a slower flowing section of the river. Nymphs were collected from the under-surface of large boulders in fairly swift current



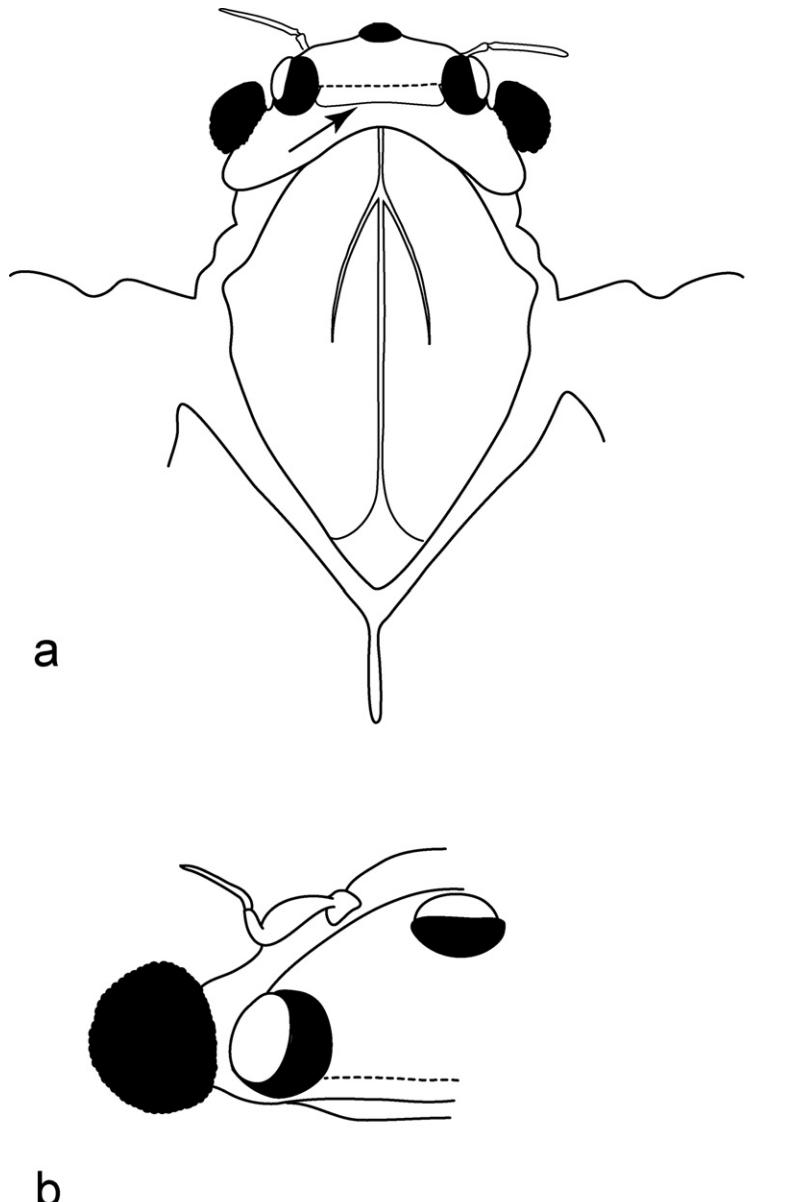
**Fig. 15.** *Prosopistoma mccaffertyi*, wings of female subimago. **a**, Forewing; **b**, hindwing. C = costa; Sc = subcosta; RA = radius anterior; RP<sub>1</sub> = first posterior radius; iRP = intercalary between RP<sub>1</sub> and RP<sub>2</sub>; RP<sub>2</sub> = second posterior radius; MA = media anterior; MP<sub>1</sub> = first posterior media; IMP = intercalary between MP<sub>1</sub> and MP<sub>2</sub>; MP<sub>2</sub> = second posterior media; CuA = cubitus anterior; CuP = cubitus posterior; AA = anal anterior. Scale bar = 1 mm.

(velocity not measured), but the presence of the silt deposits along with their less streamlined shape (when compared for example with *P. crassi* which co-occurred at several sites with this species) may indicate a microhabitat requirement

for this species in slower current. The pH of these rivers ranges from 7.6–8.3. Rivers-Moore & Jewitt (2004) give the annual water temperature range for the Sabie River near the site where this species was collected as 11–37 °C.



**Fig. 16.** *Prosopistoma mccaffertyi*. **a**, Fore-; **b**, mid-; **c**, hindlegs of female subimago. Scale bar = 0.5 mm.



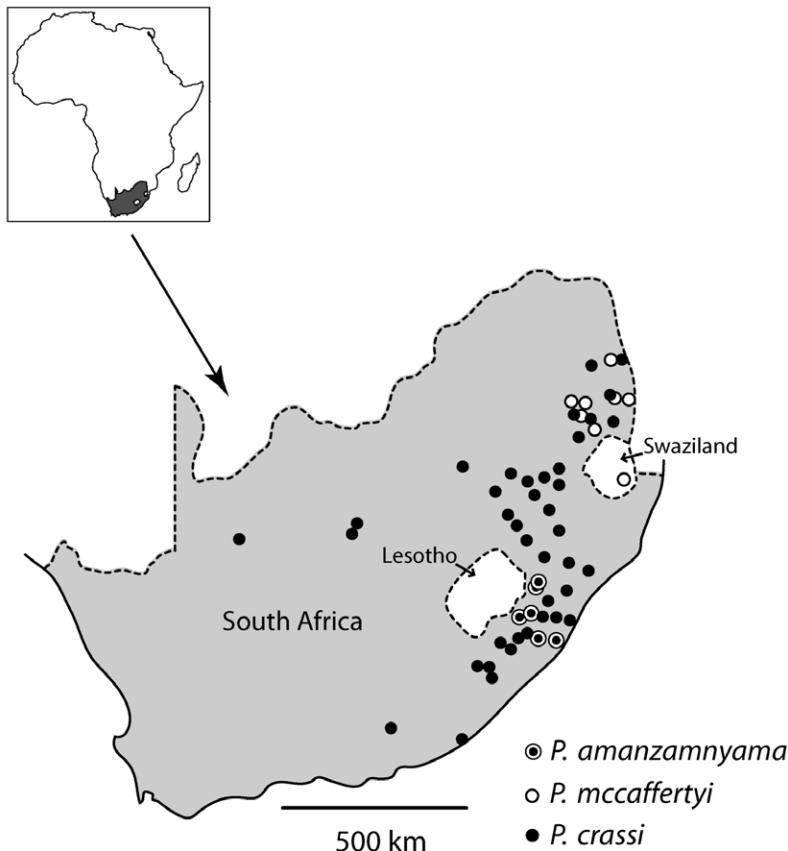
**Fig. 17.** *Prosopistoma mccaffertyi*, female subimago. **a**, Dorsal view of head and thorax; **b**, latero-dorsal view of head showing antenna. Scale bar = 1 mm.

Stomach contents revealed detritus-like matter, as in *P. amanzamnyama*, with no evidence of head capsules of prey.

#### DISCUSSION

The relationship of these two new species with respect to other known species of Prosopistomatidae

was postulated by Barber-James (2009). In the phylogeny presented, the species named 'African sp. 1' represents *P. amanzamnyama* and 'African sp. 5' represents *P. mccaffertyi*. This tentative phylogeny, based on nymphal morphology only, indicates a close relationship between these two new species, and a close relationship with two species in Asia.



**Fig. 18.** Distribution of the two new southern African *Prosopistoma* species in relation to *P. crassi*.

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18 January 2010