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THE ECOLOGY, LIFE-HISTORY AND MORPHOMETRICS OF THE AUSTRALIAN CHIGGER MITE EUTROMBICULA SAMBONI (WOMERSLEY) (ACARINA: TROMBICULIDAE)

BY R. V. SOUTHCOTT *

SUMMARY: The ecology, life history and morphometrics of the common chigger mite Eutrombicula samboni (Womersley, 1939) (Acarina: Trombiculidae) of south-eastern South Australia have been studied. Larvae were captured free-living, as well as ectoparasitic on Rattus fuscipes greyii. Captured ectoparasitic larvae have been reared to protonymphs and deutonymphs, which are described. Deutonymphs and adults caught in the field are compared with each other and the reared deutonymphs. Evidence is presented of a subadult stage being present, as occurs in the Microtrombiculidae.

Morphometric data are presented of larvae, with the type series being compared with those collected near Robe, South Australia, as well as with the morphometric data of Womersley & Heaslip (1943) and Womersley (1952). The earlier measurements of Womersley & Heaslip were significantly (and less accurately) re-estimated in Womersley (1952).

A brief historical review is given of trombiculid studies in the south-east of South Australia, with particular reference to the work of R. N. McCulloch.

INTRODUCTION

Bites to persons in various restricted localities in the south-east of South Australia from larval trombiculid mites ('chiggers') are known as 'tea-tree itch', 'duck-shooters itch' and various other names. The first to identify these irritating skin lesions as the results of the bites of larval trombiculid mites was Hirst (1929a, b, c), then on the staff of the Zoology Department, University of Adelaide, who

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captured some of the larvae, and identified them as *Trombicula hirsti* Sambon, 1927, a species which Sambon (1927) had recorded as causing similar irritating skin lesions in northern Queensland. Womersley (1934, 1937) initially accepted Hirst’s identification, but after examining an authentic specimen of *hirsti* described the South Australian species as *Trombicula samboni* Womersley, 1939. This species is currently known (Domrow & Lester, 1985) as *Eutrombicula samboni* (Womersley, 1939).

Hirst (1929b) described a further species of larval trombiculid from the south-east of South Australia as *Schongastia coorongense* Hirst, 1929 from a dead rat collected in Robe. This species is currently known (Domrow & Lester, 1985) as *Guntheria (Derrickiella) coorongensis* (Hirst, 1929). Its life-history and ecology will be presented in another paper.

With the entry of Japan into World War II, in December, 1941, the military forces of the Allied armies were exposed to various tropical diseases. Notable among these was scrub typhus, endemic over a large zone from south-eastern Asia and Japan to New Guinea and northern Australia, with a high mortality. This disease was known to be transmitted by larval trombiculid mites, from rodent or other animal reservoirs. This resulted in a considerable effort amongst various of the Allied forces to undertake measures to protect combatant troops, which therefore required knowledge on the trombiculid mite fauna and its ecology.

Within the Australian Army an Entomological Unit (or Section) was allotted to these studies, with taxonomic support from Herbert Womersley at the South Australian Museum. The Entomological Unit was commanded by Robert N. McCulloch, then Captain. It was considered that the trombiculid mite fauna of the south-east of South Australia would serve as a suitable model for preliminary studies, without the risk of infection from typhus known to occur in various northern Australian localities.

In early April, 1943, McCulloch took six personnel to the vicinity of Robe, South Australia. A few days later Womersley was also transported by the Australian Army to Robe, to study the same subject and to provide taxonomic support.

Both McCulloch and Womersley collected similar data on tea-tree itch mites and biting in the Robe area (R. N. McCulloch, pers. comm., 1988), Womersley’s record being published in Womersley & Heaslip (1943). Womersley visited the Robe district twice in April, from 5th to 9th April, and from 16th to 21st April (Report of the South Australian Museum Board, July 1st, 1942 to June 30th, 1943).

McCulloch found that some members of his Unit were attacked by the mites, but others, who had had dimethyl phthalate applied to some of their clothing, were not attacked. Soon afterwards mite-biting ceased, this being attributed to cold weather ensuing with a lack of larval mites, and accordingly the Unit transferred to northern Queensland.

Womersley recorded, however (Womersley & Heaslip, 1943, p. 95), that “even on the occasion of our (sic) visits they [the larval trombiculid mites causing tea-tree itch] were abundant even though the weather was cold and wet.” Despite this statement, the South Australian Museum mite collection does not contain any larval trombiculids resulting from Womersley’s or McCulloch’s visits to the Robe area in April, although slide data in the collection show that post-larval s of *E. samboni* were collected in April by Womersley, also in October, 1943, localized as ‘Robe’ (see list of material examined). Womersley also recorded (loc. cit., p. 96) that “search on the second visit discovered numerous specimens of both stages [nymphs and adults of *E. samboni*] in the black soil, chiefly in the top inch, and especially near spots where rabbits had been scratching and stamping.” This remark refers to the visit of 16–21 April, as the paper by Womersley & Heaslip was published in July, 1943. In the paper by Womersley & Heaslip the adult of *Eutrombicula samboni* is described and figured, and the nymph is described. The South Australian Museum’s acarological collection contains one deutonymph of April, 1943, and one deutonymph and one adult labelled October, 1943 (see list of material examined).

In neither of these post-larval s of *E. samboni* collected by Womersley was correlation with the
larva based on experimental rearing, but only on field association. These post-larvae were redescribed, with further figures of the adult, by Womersley in 1952.

Plan of investigation:
It was therefore clear that there were considerable gaps in knowledge of the life history of this long-described species of trombiculid mite of the south-east of South Australia, which was known to cause significant medical problems, and possibly also of trombiculid taxonomy. It was therefore proposed to restudy the problem. The author had the offer of assistance in field collecting and ecological work from Dr. R. N. McCulloch, whose previous association with these studies has been referred to above, and recorded in McCulloch (1944, 1946, 1947).

Study trips were made to the Robe district in April, 1987, and in March of 1988, 1989 and 1990. The weather of April, 1987 was generally cold with some showers, and no larval trombiculid mites were obtained. A few post-larvae of Eutrombicula samboni were obtained by Berlese funnel extractions of soil samples. In the subsequent three years, numerous larvae of E. samboni were obtained by field study methods, as well as post-larvae from Berlese funnel and flotation extractions of soil. From captured rodents many specimens of larvae of Guntheria coorongensis, and a few of E. samboni, were obtained, from which it was possible to rear protonymphs and deutonymphs. No adult of G. coorongensis was obtained. Several adults of E. samboni were obtained, but attempts to obtain oviposition of captive specimens, confined in tubes with soil, were unsuccessful.

Larvae resulting from these studies have been compared with the type series in the South Australian Museum. It also became possible to redescribe the deutonymph of Eutrombicula samboni, firmly correlated with the larva by experimental rearing, and to redescribe the similar adult instar of this species.

MATERIALS AND METHODS

Trips were made to the Robe, South Australia, area, of four to five days, in April 28 to May 1, 1987, March 14–18, 1988, March 13–17, 1989, and March 19–23, 1990. Enquiries were made of local District Council Officers, and various residents as to possible areas of “tea-tree itch”. Various sites in the vicinity of Robe township were examined on the advice of local residents.

Larval trombiculid mites were sought by standing in possible suitable areas and examining boots (the ‘boot method’), small pieces of dark serge cloth and other objects (Fig. 1A). On the first trip, in 1987, no larvae were found by these methods, even in areas where there was ample evidence of rabbits. We were advised, with respect to a well-known area alongside tea-tree (Leptospermum lanigerum (Aiton)), that ‘it was rather late’ in the ‘mite season’. Traps were set for small rodents in suitable areas but in 1987 no animals were captured. Soil samples were taken for later Berlese funnel extraction, and these, for each of the trips, yielded post-larvae of Trombiculidae (Eutrombicula samboni) and other trombidioid mites, as well as other arthropods.

For each of the trips of 1988–1990 the same study methods were used, and yielded many larvae of trombiculids. No anti-mite protection of the two field investigators (Southcott and McCulloch) was used in 1987 and 1988. In 1989 and 1990 McCulloch used dimethyl phthalate as a protectant, and received no bites; Southcott used none and received numerous bites.

The main site studied was at the edge of tea-tree scrub, at MR (Penola 1: 250,000) 283411, near a swamp edge, on ‘Hermitage homestead’ property, to which we were directed by the owners, Messrs P. R. and J. Enright. Over 1988, 1989 and 1990 this site yielded many larvae of E. samboni. Rodents were trapped by Ellitt traps at this and other sites; they were nearly all Rattus fuscipes greyii Gray (see Lunney, 1983) but a few were Mus domesticus L. These were usually carrying many trombiculid mites as parasites in the pinnae, nearly all of G. coorongensis, sometimes with a few E. samboni (Fig. 1B). Mites were removed from the ears and some were preserved, but most were placed in small wet tubes on wet blotting paper, initially in batches before it was realized two species were present, later individually. Some rats were kept live
in cages over a water surface, upon which the mites dropped, to be recovered and placed in individual tubes.

Samples of soil, mainly from the principal site, were examined by flotation methods or Berlese funnel extractions. Live post-larval trombidioids so obtained were confined with a small amount of soil in the hope that oviposition could be used in adult-larva correlations, but no oviposition was observed. For the 1990 trip large samples of soil were taken (Fig. 1C), and kept in an area from which no trombiculid or other trombidioid mites had been observed in over 20 years, and fractions of these were removed monthly for Berlese funnel extractions, over the succeeding 12 months. By this means further post-larval trombidioids, including *E. samboni*, were obtained. Additionally, a number of other post-larval trombidioids were recovered, including a new trombellid mite (SOUTHCOTT, 1991b).

Microscopy was by Leitz Ortholux microscope, with phase-contrast and polarizing facilities. Leitz and Olympus measuring scales were checked mutually for accuracy. For low power microscopy of rearing tubes, etc., a Wild M5A microscope was used.

Mites selected for detailed study were mounted in Hoyer’s medium after clearing in 50% lactic acid solution.

Line drawings were made using a drawing attachment to the Ortholux microscope.

Photography was by Leica M3 camera with bellows and rings extension and 65, 35 and 25 mm lenses.

All measurements are in micrometres (μm) unless otherwise specified.


Abbreviations used: A = Registration prefix for author’s ‘Animal’ series. ACB = Registration prefix for author’s Trombidioidea. N = Registration prefix for South Australian Museum arachnology collection. SAM = South Australian Museum.

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**Eutrombicula samboni** (Womersley)  
(Figs. 1D, E, 2A–D, 3A, B, 4A–E, 5A–H, 6A, B, 7A, B)

*Trombicula hirsti* Sambon — Hirst, 1929a: 451 (part); 1929b: 564 (part); 1929c: 165 (part); 1929d: 24 (part); Womersley, 1934: 212 (part); 1937: 81 (part); non *Trombicula hirsti* Sambon, 1927.


For other synonymy see Domrow & Lester (1985).

Lectotype. Robe, Dec. 1928, S. Hirst, one larva of a slide of two, bearing labels ‘Tea tree mites’ in Hirst’s writing, also ‘Dec. 1928’, Womersley’s identification label, also ‘Ty’ in Womersley’s hand, Domrow & Lester’s designation label, and registration numbers N198649 and ACB1284A.

Paralectotypes. Robe, one larva on same slide as lectotype and same labels, registration numbers N198650 and ACB1284B. Port MacDonnell, 1.I.1934, E. S. Alcock, eight larvae on one slide labelled N1993-1 and ACB1285A–H, ‘Ty swamp itch mite’ (from D. C. Swan, Waite Institute, University of Adelaide) (specimen ACB1285A was described and figured by Womersley (1939) and is redescribed and figured below). Robe, Jan. 1938, Miss C. M. Eardley, six larvae, N1993-2 and ACB1286A–F (specimens are slightly damaged, having presumably been removed from a ‘tea-tree itch’ sufferer; Miss Eardley was a botanist who worked in various localities in South Australia).

Other material. Robe, April, 1943, H. Womersley, one deutonymph N1993-3 and ACB1287, labelled ‘Ty. ?’ in Womersley’s writing; 13.x.1943 one adult N1993-4 and ACB1288, labelled ‘Type’ and ‘?’ in Womersley’s writing; 13.x.1943, one deutonymph (damaged) N1993-5 and ACB1289, labelled ‘Type d’ in Womersley’s writing, later crossed out and replaced by ‘Paraty. ?’ Beviliques (sic for Bevilacqua) Ford, two miles (3km) S. of Rendelsham, H[undred] of Rivoli Bay, no date or...
collector, one larva N1993-6 and ACB1290, label­led in an unidentifiable hand also 'Trombicula
samboni Worn.' (specimen excluded from the type
series by DOMROW & LESTER (1985); nevertheless
they used its scutum for their figure of *E. samboni*).

1 km E. of Hermitage Homestead, MR (Penola
1:250,000) 283411, 1987–1990, many larvae and a
few post-larval s, the larvae collected either ectopa­
rasitic on *Rattus f. greyii* pinnae (a few) or by hand
from boots and other objects placed on the ground,
or ectoparasitic upon *Homo sapiens*; the post­
larval s collected by flotation from soil, or by
successive Berlese funnel extraction from soil sam­
ples , as stated in 'Materials and methods', or reared
from larvae parasitic on *Rattus f. greyii*. Numerous
larvae were caught free in March at the collecting
site in 1988, 1989, 1990 (R. V. SOUTHCOTT and R.
N. McCULLOCH). Post-larval s captured from soil
were subadult ACB972 from soil sample of
30.IV.1987, extracted on 25.V.1987; one adult
ACB976 extracted from soil on 30.V.1987; two
adults ACB998 and 999 extracted from soil by flota­
tion technique on 15.III.1988; one adult
ACB1131 from soil collected on 22.III.1990, extracted on
2.IV .1990; one subadult ACB1176 from soil sample

Rearing experiments with larvae obtained from
*Rattus f. greyii* at the Hermitage site have yielded
two deutonymphs (nearly all of the larvae in the
pinnae of *Rattus f. greyii* were of *Guntheria cooron­
gensis* (Hirst)).

*Rattus f. greyii*, specimen A2930, captured
23.III.1990, was confined in a cage over a water
surface. Three larvae were recovered from the water
and placed in wet tubes. Two (ACB1126A, B) were
*G. coorongensis*. The third, ACB1126C, was one of
*E. samboni*, which transformed to a deutonymph
(see below).

Larva ACB991B/D1 was removed from the
left ear of *Rattus f. greyii* A2858 on 17.III.1988;
it was one of a mixed batch of *Guntheria coorongen­
sis* and *Eutrombicula samboni* larvae (eventu­
ally found to contain seven *Guntheria* and two
*Eutrombicula*). From this experiment one larva and
one deutonymph of *E. samboni* were obtained, but
the larval pelt of the deutonymph was not recove­
red.

**Larva**

This species was erected by WOMERSLEY from the
larva. WOMERSLEY did not nominate a type speci­
men in any of his publications. DOMROW & LESTER
(1985) selected a specimen on one of three slides,
stating that "it is now chosen as type" (i.e. lectotype), and defined other specimens from Robe
as paratypes (actually paralectotypes).

As the specimen selected by DOMROW & LESTER
was an early specimen collected by S. HIRST, with
fine detail now difficult to see even with phase-
contrast, it is briefly described below, and a de­
scription given of the larva used for description and
figures by WOMERSLEY (1939).

It is proposed to compare lectotype and paralecto­
type, as well as others of the type series as utilized
by WOMERSLEY (in WOMERSLEY 1939, 1952, and
WOMERSLEY & HEASLIP, 1943) with a series collec­
ted at the Hermitage site in 1988–1990, also larva
ACB1126C, to establish firmly the correlations
between the larva and the post-larval s.

**Description of lectotype larva** (N198649,
ACB1284A), slide-mounted

Colour in life "pale reddish" (HIRST, 1929b).
Idiosoma oval in outline, length 195, width 175;
total length 275. Dorsal scutum with anterior
border slightly concave, with a slight anterior
central convexity; lateral borders almost straight,
posterior border convex, evenly rounded; scutum
contour smooth except for slight projection at the
AL seta bases ; scutum minutely porose, without
special markings. Scutalae pointed, lightly setulose
with barbed setules. Sensillar setae lost.

Dorsal idiosomal setae similar to scutalae, in
rows: 2 (humerals), 6, 6, 6, 4, 4, 2. Coxalae and
other ventral setae similar; coxalae 1, 1, 1. One pair
of sternalae between coxae I and one pair between
coxae III. Behind coxae III about 18 setae,
arranged 4, 4, 4, 4, 2.

Legs rather crumpled, unsuitable for detailed
description and measurement, but appear similar to
specimen described and figured by WOMERSLEY
(redescribed below).

Gnathosoma: cheliceral bases pyriform, each 50
long by 33 wide; cheliceral digits curved, pointed,
45 long, with small apical cap. Galeala simple, pointed, 16 long. Gnathobasal (i.e. gnathosoma coxal) setae pointed, 23 long, with several long setules. Palpi crumpled, unsuitable for detailed description.

Metric data as in Table 1.

Redescription of paralectotype larva: ACB1285A (slide-mounted) (Figs. 2A, C, D, 3A, B)

Colour in life not recorded. Idiosoma near-circular in outline, length 210, width 182; total length of animal to tip of chelicerae 293.
| Character | AW | PW | SB | ASB | PSB | L | W | AAS | AF | AM | AL | PL | Sens | DS | Hum | MDS | PDS | GeI | TL | TII | GeI/TII | TII/TII(L) | TII(H) | TIII | TIII(GeI) | TIII(II) | TIII(III) | TaII(L) | TaII(H) | TaIII | TaIII(III) | TaIII(TII) | TaIII(H) |
|------------|----|----|----|-----|-----|---|---|-----|----|----|----|----|-----|-----|----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| Specimen   | 78 | 87 | 36 | 33 | 40 | 73 | 95 | 29 | 27 | 36 | 42 | 44 | 67 | 49 | 51 | 39-41 | 42-44 | 38 | 23 | 1.24 | 30 | 42 | 58 | 20 | 1.40 | 32 | 47 | 71 | 18 | 1.47 | 0.77 | 1.12 | 0.95 | 1.68 | 1.81 | 0.55 | 3.22 |
| Lactotype  | 79 | 85 | 35 | 34 | 39 | 73 | 91 | 29 | 32 | 34 | 44 | 47 | 71 | 49 | 51 | 37-40 | 37-46 | 15 | 16 | 16 | 16 | 16 | 16 | 16 | 16 | 16 | 17 | 16 | 16 | 16 | 16 | 16 | 16 |
| Paralactotype described | ACB1285A | ACB1285A | ACB1285A | ACB1285A | ACB1285A | ACB1285A | ACB1285A | ACB1285A | ACB1285A | ACB1285A | ACB1285A | ACB1285A | ACB1285A | ACB1285A | ACB1285A | ACB1285A | ACB1285A | ACB1285A | ACB1285A | ACB1285A | ACB1285A | ACB1285A | ACB1285A | ACB1285A | ACB1285A | ACB1285A | ACB1285A | ACB1285A | ACB1285A | ACB1285A | ACB1285A | ACB1285A | ACB1285A |
| n          | 16 | 16 | 16 | 17 | 17 | 17 | 16 | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 16 | 16 | 16 | 16 | 16 | 16 | 16 | 16 | 16 | 16 | 16 | 16 | 16 | 16 | 16 | 16 | 16 | 16 | 16 |
| mean       | 81.3 | 89.4 | 36.2 | 31.6 | 37.7 | 69.4 | 95.1 | 31.1 | 28.5 | 37.8 | 41.5 | 46.9 | 73.9 | 54.2 | 54.2 | 42.5 | 43.4 | 44.1 | 24.5 | 28.3 | 41.5 | 58.4 | 21.7 | 1.47 | 74.6 | 18.8 | 1.55 | 20.8 | 46.3 | 47.6 | 22.2 |
| s.d.       | 2.79 | 2.56 | 1.76 | 2.15 | 2.52 | 3.18 | 2.16 | 1.50 | 1.84 | 2.45 | 2.27 | 2.95 | 3.72 | 2.58 | 2.58 | 4.04 | 2.03 | 3.28 | 2.10 | 1.49 | 1.65 | 1.93 | 1.85 | 1.47 | 4.2 | 1.68 | 5.7 | 0.0883 | 21.9 | 2.71 | 1.68 | 5.3 | 21.9 | 3.6 |
| c.v.       | 3.4 | 2.9 | 4.9 | 6.8 | 6.7 | 4.6 | 2.3 | 4.8 | 6.2 | 5.5 | 5.5 | 6.3 | 5.0 | 4.8 | 4.8 | 9.4 | 4.7 | 8.5 | 8.6 | 5.3 | 3.9 | 3.3 | 8.5 | 4.7 | 5.3 | 8.5 | 5.7 | 0.0883 | 4.5 | 3.6 | 8.9 | 4.9 | 8.5 | 3.6 |
| Control series from 'Heritage' site | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 |
| range      | 79.0 | 86.8 | 34.8 | 31.7 | 38.4 | 70.1 | 93.5 | 30.4 | 27.7 | 38.6 | 40.6 | 47.0 | 71.2 | 53.2 | 53.2 | 42.7 | 41.4 | 35.0 | 25.2 | 26.9 | 41.0 | 58.2 | 21.7 | 1.53 | 75.6 | 18.8 | 31.2 | 49.7 | 58.2 | 1.23 | 18.8 |
| mean       | 2.42 | 1.67 | 1.28 | 2.11 | 1.54 | 2.39 | 2.56 | 1.35 | 1.63 | 3.08 | 2.13 | 2.94 | 4.35 | 2.28 | 2.28 | 2.39 | 2.52 | 1.65 | 1.85 | 1.48 | 3.27 | 2.06 | 1.18 | 0.59 | 3.14 | 0.85 | 1.23 | 1.69 | 2.06 | 1.9 | 0.85 |
| s.d.       | 3.1 | 1.9 | 3.7 | 6.7 | 4.0 | 3.4 | 2.7 | 3.1 | 5.9 | 8.0 | 6.3 | 6.4 | 4.3 | 4.3 | 5.6 | 6.1 | 4.7 | 8.0 | 5.5 | 3.7 | 6.1 | 5.5 | 5.5 | 5.5 | 6.1 | 5.5 | 5.5 | 3.5 | 5.6 | 4.5 | 3.9 | 3.4 | 3.2 | 4.5 | 3.5 |
| c.v.       | 82 | 92 | 38 | 32 | 37 | 69 | 97 | 32 | 31 | 40 | 45 | 55 | 64 | 43 | 43 | 5.6 | 61 | 47 | 22 | 29 | 43 | 61 | 22 | 60 | 1.48 | 32 | 23 | 39 | 5.5 | 43 | 5.5 | 3.5 | 5.6 | 4.5 | 3.9 | 3.4 | 3.2 | 4.5 | 3.5 |

* Includes ACB1290; see text.
** For maximum values.

Table 1: Metric data for *Eutrombica samboni* (Womersley) larvae.
FIG. 2: *Eutrombicula samboni* (Womersley), larva.

A. — Dorsal view, legs omitted on right, of paralectotype ACB1285A. B. — Dorsal idiosomal scutum of larva of ACB1126C, from which deutonymph was reared. C. — Dorsal idiosomal seta (‘c’ in A). D. — Palp of ACB1285A, dorsal aspect. (A, B to scale of left; C, D to scale on right.)
FIG. 3: Eutrombicula samboni (Womersley), larva, paralectotype ACB1285A.
A. — Ventral view, legs omitted on right. B. — Palp, ventral aspect. (Each to nearer scale.)
Dorsal scutum and scutalae as for lectotype. Sensillary setae filiform with 4–5 slender setules in distal 1/2. Eyes 2 + 2, conjoined, anterior 12 across, posterior 8. Dorsal idiosomal setae as for lectotype, arranged 2 (humerals), 6, 6, 4, 4, 2? (posteriorad somewhat asymmetrical and irregular).

Ventral surface of idiosoma: sternalae pointed, with a few long setules, anterior sternalae near medial ends of coxae I, 53 long, unilaterally setulose; posterior pair between levels of coxae II and III, similar to preceding, 46 long. Behind coxae III rows of setulose setae, 35–41 long, arranged 6, 6, 3; anteriormost similar to sternalae, posteriorad thicker and with shorter barbed setules, resembling PDS. Urstigma oval, with central circular pit 6 across.

Coxalae 1, 1, 1, pointed, with long setules; on I, II, II 53, 35, 48 long respectively.

Legs of usual trombiculid stature, lengths (trochanters to claw-tips) I 275, II 235, III 278. Leg scobalae pointed, setulose.

Leg specialized setae as follows: SoGeI.30ad(16), SoGeI.66ad(21), VsGeI.66pd(3), SoTiI.67pd(15), VsTiI.69pd(4), SoTiI.93d(15). SoGeI.50d(15), SoTiI.58pd(15), SoTiI.88d(17). SoGeII.41pd(15), SoTiII.44d(15).

Tarsus I with FaTa.41pd(c.2), SoTaI.42d(15).

Tarsus II with FaTaII.48pd(minute), SoTaII.49d(14).

Tarsus III with MaTaIII.25d(73).

Gnathosoma: chelicerae as for lectotype; cheliceral base 55 long by 34 wide, cheliceral digit 47 long. Galeala slender, pointed, simple, 30 long. Gnathobasal setae 36 long, with 5–6 long setules. Palpal setal formula 0, 1, 1, 3, 8, as figured, characters: B, B, BBN, 6B + 1N + 1So.

Remarks on the type series

As with the great majority of the Trombiculidae, the species is founded on the larval instar. Paralecotype specimen ACB1285A, on which the description is mainly based, was similarly used by WOMERSLEY, as being the clearest and best positioned (in the mount) of the specimens he had available. Additionally, WOMERSLEY's description was of a specimen possessing both AM and scutal sensillary setae, which is not the case in the two Hirst specimens in the South Australian Museum collection. WOMERSLEY (1934) saw two slides, each with two larvae, of Hirst's collecting (of 3–6 December, 1928), one of which was retained in the Museum collection; it has apparently not been remounted. In 1934 WOMERSLEY could also have had available the slide of eight specimens (ACB 1285A–H). In 1939 he stated that samboni was 'Common in the ti-tree scrub along the Coorong, South Australia', but did not refer to any further specimens. Apart from these 10 specimens, WOMERSLEY in 1939 would have had available the six further specimens, ACB1286A–F, from Robe, January 1938, collected by Miss Eardley.

It is possible that in 1943 WOMERSLEY still had available the second Hirst slide of two specimens, since there are no larvae of WOMERSLEY's collection from his visits to the Robe area, and WOMERSLEY & HEASLIP (1943) record having measured 10 larvae from Robe, as well as the eight from Port MacDonnell.

WOMERSLEY (1937) recorded having seen a specimen of 'Trombicula hirsti' found on a blackbird (Turdus merula) at Payneham (a suburb of Adelaide) on 30 VI 1937. This specimen is not in the Museum's collection. The only additional larva in the Museum's collection, prior to the present study, was the undated single specimen (ACB1290) from Bevilacqua Ford, south of Rendelsham.

WOMERSLEY (1952, p. 101) in his monograph on the Trombiculidae, stated that his metric data of the larvae 'is derived from 20 specimens'.

If all of the material referred to above had been available in 1952, WOMERSLEY would have had 20 larvae available for measuring, but it seems unlikely that he would actually have had 20 specimens available.

DOMROW & LESTER (1985, p. 35) refer to WOMERSLEY (1952) changing 'small details' from his previous data. The present author has elsewhere (1986a, 1986b, p. 15) referred to WOMERSLEY's inaccuracies with field data.

WOMERSLEY's metric data of Eutrombicula samboni

WOMERSLEY successively offered metric data of characters of his available series of E. samboni
Table 2: Comparisons of measurements of means of *Eutrombicula samboni* (Womersley) type series of larvae.

<table>
<thead>
<tr>
<th>Character</th>
<th>Womersley (1939)</th>
<th>Womersley &amp; Heaslip (1943) (n=18)</th>
<th>Womersley (1952) (n=20)</th>
<th>Difference (%) between Womersley &amp; Heaslip (1943) and Womersley (1952)</th>
<th>Present study (n=17)</th>
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<tbody>
<tr>
<td>AW</td>
<td>–</td>
<td>78.5</td>
<td>87.8 ± 0.87*</td>
<td>+ 11.2</td>
<td>+ 11.2</td>
</tr>
<tr>
<td>PW</td>
<td>–</td>
<td>87</td>
<td>97.7 ± 0.83*</td>
<td>+ 11.2</td>
<td>+ 11.2</td>
</tr>
<tr>
<td>SB</td>
<td>–</td>
<td>36</td>
<td>39.7 ± 0.44*</td>
<td>+ 11.0</td>
<td>36.2</td>
</tr>
<tr>
<td>ASB</td>
<td>–</td>
<td>24</td>
<td>39.05 ± 0.44**</td>
<td>+ 62.7</td>
<td>31.7</td>
</tr>
<tr>
<td>PSB</td>
<td>–</td>
<td>36</td>
<td>29.2 ± 0.32*</td>
<td>- 18.9</td>
<td>37.7</td>
</tr>
<tr>
<td>SD(L)</td>
<td>65</td>
<td>(60)</td>
<td>68.2 ± 0.63*</td>
<td>+ 13.7</td>
<td>69.4</td>
</tr>
<tr>
<td>A-P</td>
<td>–</td>
<td>30</td>
<td>31.6 ± 0.30*</td>
<td>+ 5.3</td>
<td>29.5</td>
</tr>
<tr>
<td>AM</td>
<td>39</td>
<td>38</td>
<td>40.3 ± 0.32*</td>
<td>+ 6.1</td>
<td>37.8</td>
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<tr>
<td>AL</td>
<td>39</td>
<td>42</td>
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<td>PL</td>
<td>47</td>
<td>48</td>
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<td>+ 8.5</td>
<td>46.9</td>
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<tr>
<td>Sens</td>
<td>65</td>
<td>68.5</td>
<td>72.2 ± 0.95*</td>
<td>+ 5.4</td>
<td>73.9</td>
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</tbody>
</table>

* Presumably the standard error of the mean.

Comparisons between the type series of *Eutrombicula samboni* larvae with a series from the Robe area, 1988–1990

In Table 1 the metric data of the “type series” of 17 larvae are compared with a series of 20 free-living larvae captured by the “boot method” at the Hermitage site on 15.III.1988. Inspection shows a considerable overlap of the data for each measure used. Only the one species of *Eutrombicula, E. samboni,* was present in the specimens captured over 1988–1990. Table 1 shows also the metric data of specimen (larva) ACB1126C, from which a deutonymph was reared, described below. The metric data of ACB1126C also match those of both series of larvae.

Protonymph (from specimen ACB1126C)

Colour reddish, shape typical of trombiculid protonymph; length (estimated, not measured accurately) 400–500.

Description of deutonymph (from ACB1126C, freshly emerged, then slide-mounted) (Figs. 1D, 4A–E).

Colour in life ‘orange-red’ on emergence, ‘legs paler’; three days later described as ‘red’ (see Fig. 1D).

Idiosoma ovoid, somewhat waisted, on slide idiosoma 585 long, maximum width (across ‘shoulders’) 395; total length to tip of cheliceral digits 740 (in life measurements were 540, 300, 600 respectively) (estimated from Kodachrome). Idiosoma heavily invested with pointed, setulose setae, lengthening posteriorad; each seta arising from a small circular to oval basal plate. Crista of normal trombiculid structure, moderately chitinized; anterior end forks to contain a seta (tectal or epistomal seta), then extends anteriorly into a diaphanous
Fig. 4: Eutrombicula samboni (Womersley), reared deutonymph ACB1126C.

A. — Entire, in transparency, setae mostly omitted. B. — Group of posterior dorsal idiosomal setae. C. — Ventral view of gnathosoma and coxae I and II. D. — Pulp, dorsal aspect of genu to tarsus. E. — Same, ventral aspect. (Each to nearest scale).
epistome with several acute-ended extensions. Sensillary setae filamentous. Eyes absent. Metric data as in Table 3.

Ventral surface of idiosoma: between medial ends of coxae I and II a hexagonal 'sternal area', with c. 8 setulose setae, similar to other setae of venter of idiosoma; 'sternal area' almost closed posteriorly by transverse bars extending from medial edges of coxae II. External genitalia with two laterally valves, each c. 80 long by c. 40 wide; anterior ends of valves moderately chitinized, remainder weaker, each valve with two subequal oval acetabula, anterior 24 long by 14 wide, posterior 18 long by 12 wide. Anus oval, with two valves, each c. 45 long by 15 wide, with a folded chitinous structure internal to the anterior end (see Fig. 4A).

Legs comparatively short; leg I the longest, about 2/3 as long as idiosoma, others considerably shorter; lengths (trochanters to claw-tips) I 405, II 260, III 255, IV 325. Claws of leg I small, others larger. Leg scobalae pointed, setulose; peripheral segments of legs, particularly of leg I, with numerous sensory setae (solenoidalae).

Gnathosoma: each lateral cheliceral base about 115 long by 27 wide, bearing dorsally a few setulose setae.

Cheliceral digits curved, pointed, c. 40 long, with c. 18 fine dorsal denticles.

Palpi slender, bearing a few pointed, setulose setae. Palpal tibia with simple, curved odontus and two medial, curved, blunted, spathulate spinisetae (paradonts), as well as a few pointed, setulose setae. Palpal tarsus conical, blunt-ended, with several setulose scobalae and 3 or 4 apical solenoidalae.

Description of adult (from specimen ACB976, slide-mounted) (Figs 5A–G, 6A, B, 7A).

Colour in life red. Idiosoma of usual adult trombiculid shape, flattened, rounded posteriorly, waisted at about the levels of coxae III and IV. Idiosoma c. 1300 long by c. 800 wide where widest (across 'shoulders'); total length to tip of chelicerae c. 1600 (in life these dimensions 960, 570, 1260 respectively). Idiosoma thickly invested with pointed, setulose scobalae, longer posteriorad; each arising from a small circular to oval basal plate.

Crista of normal trombiculid structure, moderately chitinized, forking anteriorly to enclose a diaphanous epistome, with one pointed, setulose epistomal (tectal) seta, near the point of forking. Sensillary setae filamentous with 2–3 slender distal setules. Crista continues posteriorly to a subcuticular rounded pole; laterally the posterior sensillary area has curved, chitinous extensions (see further comment below). Eyes absent.

Metric data as in Table 3.

Ventral surface of idiosoma: thickly invested with setae similar to dorsal. Between coxae I and II an enclosed sternal area, pentagonal, bearing 10 strong, pointed, setulose setae 20–38 long. All coxae with numerous pointed setulose setae. External genitalia 190 long by c. 135 wide, with two lateral valves, each with many setulose setae, also a few pointed, simple setae 30–33 long; with three oval subequal acetabula on each side, 29–33 long by 18–20 wide. Anus 95 long by 60 wide, with two well-chitinized valves, each carrying 10–12 setulose setae similar to those on surrounding idiosoma.

Legs: of normal trombiculid stature, leg I the longest and thickest, with the smallest claws, lengths (trochanter to claws-tips) I 720, II 440, IV 575. Setation similar to that of deutonymph.

Gnathosoma: each cheliceral base 160 long by 55 across. Cheliceral digits strong, pointed, curved, 85 long; each dorsal edge with c. 25 fine, retrorse denticles. Palp robust, moderately setose; dorsal setae simple, pointed, except for a few unilaterally setulose setae; ventral setae setulose. Palpal tibia with two ventral setulose setae; other setae pointed, simple. Odontus blunt-pointed, accompanied medially by three curved, slender, blunted paradonts. Palpal tarsus elongate-ovoid, with c. 10 setulose setae, and terminally, 5–6 solenoidalae.

Remarks on morphology

The post-larval Trombiculidae, living subterranean lives, lack eyes. The curved chitinous bars projecting laterally from the sensillary area tend to resemble the edges of eyes, and were so identified by e.g. BERLESE (1912, p. 93) and WOMERSLEY (1952).
Subadult stages in *Eutrombicula samboni*

A subadult stage has been identified among the family Microtrombidiidae of the Trombidioidea, in which successive adult moultings occur (Michener, 1946; Southcott, 1994).

Among the seven specimens of post-larval at first identified as adults on the basis of the genitalia having 3 + 3 acetabula were two in which the third pair of acetabula were significantly smaller than the anterior and middle pairs. This situation matches those of proven subadults among the Microtrombididae. The specimens do not otherwise appear to be distinguishable from adults with 3 + 3 subequal acetabula. The genitalia of one specimen are shown in Fig. 5H; the metric data of all available adults and subadults, as well as deutonymphs, are shown in Table 3. The other subadult, specimen ACB972, is shown in Fig. 1E.

<table>
<thead>
<tr>
<th>Specimen</th>
<th>Deutonymphs</th>
<th>Subadults</th>
<th>Adults</th>
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<td>ACB991B/D1</td>
<td>ACB1126C</td>
<td>ACB1287</td>
<td>ACB1289</td>
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<td>T2III(H)</td>
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<td>1.10</td>
<td>1.32</td>
<td>1.18</td>
</tr>
</tbody>
</table>

1 From Audy (1953).
* From Womersley & Heaslip (1943) and Womersley (1952).
** From Womersley (1952, Plate 89).

Table 3: Metric data of *Eutrombicula samboni* (Womersley), for deutonymphs, subadults and adults.
Fig. 5: Eutrombicula samboni (Womersley).

H. — Subadult specimen ACB1176, external genitalia. (A to scale on left, B–H to scale on right).
Correlation between larval and post-larval instars

In WOMERSLEY & HEASLIP (1943) and WOMERSLEY (1952) are described the adult and deutonymph of *E. samboni*. This attribution was made purely on the larvae and post-larval occurring in the same general area in the south-east of South Australia.

Under “Material examined” (above) are recorded two experiments in which a deutonymph was obtained after transforming from a larva. Larva ACB1126C was recovered after falling off its host rat on 30.III.1990. It remained plump and immobile. On 7.IV.1990 it was considered to be possibly in a protonymphal state. On 8.IV.1990 my notes record it as ‘Protonymph, [larval] skin unshed’. On 16.IV.1990 a deutonymph emerged ‘immobile in a film of water, with larval pelt alongside’. The larval pelt was recovered, mounted and identified (Fig. 2B). (The protonymphal pelt was not identified). The deutonymph was photographed live in a well slide on 17.IV.1990 and 19.IV.1990, then preserved in ethanol and mounted.

This correlation has allowed the firm correlation of the larva with the post-larvals. The interval between the larva leaving the host rat and the emergence of the deutonymph was 16 days; of this the protonymphal instar lasted nine days.

(One other deutonymph of *E. samboni* was reared experimentally, being one of a mixed batch of *E. samboni* and *Guntheria coorongensis* (ACB991C) taken from a *Rattus f. greyii* (A2858) on 17.III.1988. Eventually from the tube a deutonymph of *E. samboni* was recovered, as well as several larvae of *E. samboni* and *G. coorongensis*. Its larval pelt was not located in the tube.)

**Remarks on the biology and ecology of Eutrombica samboni**

Larvae causing ‘tea-tree itch’, i.e. *Eutrombica samboni*, in the south-east of South Australia are generally stated to be common during the summer and autumn in selected localities. Although WOMERSLEY & HEASLIP (1943) stated that larvae are found throughout the year, all identified larvae recorded hitherto or in this paper has been collected in December, January and March.

Deutonymphs have been reared in the laboratory over March–April (see experiments ACB911B/D1 and ACB1126C above), and two deutonymphs have been caught in the field, one in April and one in October. Adults have been captured in the field in March, April, May and October. One ♂ adult ACB998 (Fig. 7B) captured on 15.III.1988 lived nine months in a tube with soil (without oviposition). (See list of material examined.)

It may be postulated that the life-cycle is annual. Details of oviposition not being known, but larvae appear in the summer-autumn, and deutonymphs in the autumn, then transforming to adults, possibly in successive adult stages.
ACKNOWLEDGEMENTS

I thank Messrs P. R. and J. ENRIGHT, of 'Hermitage', Robe, for access to the principal study area. The late Dr R. N. McCulloch accompanied the author on each of the four field trips, 1987-1990 and aided in the field studies for collecting, as well as providing valuable historical data.

The Director, South Australian Museum, provided access to the Museum's acarological collection. Dr J. P. Jessop, State Herbarium of South Australia, gave plant identifications.

Identification of rodent host species was provided by Ms L. Queale, South Australian Museum.

I thank Dr N. A. Locket, of Adelaide, and Dr M. S. Harvey of Perth, Western Australia, for constructive comments on the paper.

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