Description of *Tarsonemus parawaitei*, a new species of Tarsonemididae (Acari: Heterostigmata) associated with orchard and ornamental plants in Europe, Australia and New Zealand

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Abstract

A new species of Tarsonemididae, *Tarsonemus parawaitei*, in the *waitei*-group of *Tarsonemus* is described and illustrated in detail from the adult female and male, larval female and male, and egg. The species is recorded from western Europe, Australia, and New Zealand. The species has two tibial solenidia on leg I of the adult female but only one on the adult male; this sexual dimorphism has not been reported in Tarsonemididae before, and warrants further investigation. Lindquist’s (1978) key to the *Tarsonemus waitei* group is updated in light of our results.

Key words: *Tarsonemus parawaitei*, new species, sexual dimorphism, *Tarsonemus waitei* group, Tarsonemididae, Acari

Introduction

During the 1996/97 summer, export of New Zealand apricots from Central Otago to Australia was temporarily suspended because of the presence of mites of a species of *Tarsonemus* (Acari: Tarsonemididae). The mites, initially identified by T.-K. Qin as a species in the *Tarsonemus waitei* group, were then sent to E.E. Lindquist for confirmation and further identification. Lindquist identified the mites as a new species identical to *Tarsonemus setifer* sensu Karl

(1965), a misidentification (Lindquist 1978). Since Lindquist held a record of this mite being present in Victoria, Australia, export of apricots from New Zealand to Australia was resumed.

However, species of Tarsonemus are still a concern for the New Zealand apricot industry because export of summer fruits to Australia still requires clearance of mites other than T. setifer sensu Karl (G. F. McLaren, personal communication 1997). The objectives of this paper are to describe all postembryonic instars of T. setifer sensu Karl as a new species, T. parawaitei, and to characterise the differences between it and other species of the genus in the T. waitei group.

Material and methods

Specimens for the present study were collected mostly from apricot (Prunus armeniaca L.) in Central Otago, New Zealand. We also reared the mites on apricot fruits in culture to associate the male, female and immature instars. Specimens were cleared using Nesbitt’s fluid and mounted in Hoyer’s medium, one per slide, for microscopic study. Specimens from other parts of the world were also examined (see Material examined).

Terminology follows that of Lindquist (1978, 1986a). Measurements are recorded in micrometers (μm) as a range, with the mean in parentheses. Body length is taken from the anterior margin to the posterior margin of the idiosoma, body width is measured at the widest part. The descriptive format also largely follows Lindquist (1978). Outlines of illustrations were made using an Olympus microscope with a drawing tube, and details were filled in using a Nikon E-800 microscope with phase contrast and differential interference contrast optical systems.

Repository abbreviations (after Watt 1979): NZAC: New Zealand Arthropod Collection, Auckland, New Zealand; CNCI: Canadian National Collection of Insects and Arachnids, Agriculture and Agri-Food Canada, Ottawa, Canada; UQBA: University of Queensland Insect Collection, Brisbane, Australia.

Tarsonemus parawaitei sp. nov.

Tarsonemus setifer: Karl, 1965: 347, fig. 5; not Ewing, 1939 [misidentification]

**Diagnosis**

*Tarsonemus parawaitei* can be distinguished from other species in the *waitei* group by the following combination of attributes: larva and adult with 3 setae on femur II; adult female with tergital setae *d* and *e* smooth and tapered like *c1* rather than *f*; leg I with 2 tibial solenidia, sejugal apodeme always interrupted on both sides of midline and usually on the midline; adult male with sejugal apodeme continuous, metapodosomal ventral plate ornamented with fine puncta laterally and anterior to coxisternal plates III and IV, and with finely interrupted, longitudinal striae on plates III and IV; cupules *im* close to bases of setae *e*, tarsus with *ft’* (instead of *ft”*) present, apodemes III connected with apodemes IV anteriorly; larva with *sc2* barbed basally, suture on tergite C extending posterolaterally beyond base of *c1*.

**Adult female** (Figs 1-6)

*Gnathosoma* (Figs 1, 2). Gnathosomal capsule 1.2-1.3 (1.26) times longer than wide; dorsomedian apodeme prominent, extending from union basally with circumcapitular apodeme to at least level of insertion of dorsal gnathosomal setae; basal half of ventral surface with a pair of apodemes extending divergently from midlevel of pharynx basally to unite with circumcapitular apodeme, forming roughly an ‘A’ shape with the latter. Gnathosoma with dorsal pair of setae 14-17 (15.4) μm, slender, smooth, slightly longer than ventral pair; postpalpal pair of setae about 26 μm, but often inconspicuous because of their running along a lateral furrow of gnathosoma for most of their length, inserted on basalmost third of capsule and extending distad of insertions of other gnathosomal setae. Palps short, 8-10 (9.3) μm, slightly convergent, with 2 minute setae about 2 μm; lateral femorogenual seta conical, stouter basally than dorsodistal tibiotarsal seta; ventrolateral distal process conspicuous and rounded. Cheliceral stylets short, straight, divergent basally and attached to basal levers. Pharynx with thick, heavily sclerotized, somewhat horseshoe-shaped lateral walls and with a pair of small, ellipsoidal, gland-like structures posteriorly.

*Dorsal idiosoma* (Fig. 1). Idiosoma elliptical, 1.7-2.0 (1.73) times as long as wide, with dorsal shields unornamented. Prodorsal shield subtriangular, width 90-110 (104.2) μm, length 62-72 (67.0) μm, about 1.5 times as wide...
posteriorly as long medially, with a conspicuous, trifid, crescentic apodeme posteromedially; anterior margin arc-shaped just slightly over base of gnathosoma; lateral margins slightly depressed and not covering the capitate bothridial sensilla. Stigmata opening on anterolateral margins of prodorsal shield posterolaterad of vertical setae (v1); distance between centres of stigmata and v1 6-7 (6.2) \( \mu m \); tracheal trunks extending posteriorly through atrium. Vertical setae (v1) 28-32 (29.9) \( \mu m \), less than half as long as scapular setae (sc2); both pairs of setae slightly barbed. Scapular setae 69-78 (73.2) \( \mu m \), inserted slightly posteriadi of midelevel of prodorsum, about 1.6 times as long as transverse distance between their insertions, and less than posterior width of prodorsal shield. Pits v2 usually conspicuous, close to sc2, about 2/3 along interval between bases of v1 and sc2, well posteriadi of level of stigmata. Bothridial setae nearly round-capitate, finely spiculate. Setae of opisthosomal tergites with c1, c2, d and e smooth, slender, finely tapered, but f and h slightly barbed, thicker, weakly tapered; c1 18-20 (19.1) \( \mu m \), d 16-19 (18.0) \( \mu m \) and e 15-18 (16.3) \( \mu m \), but c2 clearly longest, 30-37 (33.9) \( \mu m \); f 13-15 (13.8) \( \mu m \), h 10-12 (10.2) \( \mu m \). Cupules ih well separated from alveoli of setae h (by about three times alveolar diameter of h). Dorsolateral extensions of coxisternal plates IV slightly overlapping tergite D laterally.

Ventral idiosoma (Fig. 2). Prosternal apodeme extending posteriorly from its union with apodemes I nearly to level of medial extremities of apodemes II, uninterrupted, slightly forked, then expanded to form a faint diagonal structure as shown in Fig. 2, not connecting with sejugal apodeme posteriorly. Apodemes II not connecting medially with prosternal apodeme. Sejugal apodeme well developed, broken in three regions: a narrow interruption in middle, sometimes not very clear, and wide interruptions on either side of mid-portion. Coxal setae 1a and 2a simple, inserted on posterior margin of apodemes I and II, respectively; 1a 13-14 (13.6) \( \mu m \), 2a 14-19 (16.8) \( \mu m \). Apodemes III recurved at anteromedial extremities near coxal setae 3a, extending laterally only as far as their articulation with anterior extremities of trochanters III. Apodemes IV extending posterolaterally slightly beyond insertions of coxal setae 3b, reduced anteromedially and not connecting with each other. Poststernal apodeme between apodemes IV vestigial. Coxal seta 3a 16-19 (17.9) \( \mu m \), 3b 15-19 (16.2) \( \mu m \). Tegula moderately large, rounded, tongue-shaped, its basal width 19-24 (21.1) \( \mu m \), slightly more than twice that of trochanter IV. Lateral plates (posterolateral extensions of coxisternal plates IV) well separated medially beneath tegula. Aggenital plate roughly triangular, with anterior margin slightly convex and
posterior margin broadly rounded. Pseudanal plate (PS) subquadrate, sometimes projecting caudad of tergite H, with setae \( ps \) slender, smooth, slightly shorter than setae \( h \).

**Legs** (Figs 3-6). Legs I, II, and III similar in length (measured from tip of tarsal claw to base of femur, excluding trochanters): I 55-64 (60.0) \( \mu \text{m} \), II 48-63 (57.7) \( \mu \text{m} \), and III 58-64 (62.1) \( \mu \text{m} \); leg IV 34-45 (40.1) \( \mu \text{m} \), slender, about 2/3 as long as leg III, its femorogenu 25-33 (29.6) \( \mu \text{m} \) long, nearly 3 times as long as its tibiotarsus. Leg I with claw unguiform, on a well-developed apotele. Legs II and III each with broad, membranous pulvillus, and with paired claws symmetrically well developed. Femora I and II without markings or flange ventrally beside seta \( v' \). Number of setae and solenidia (indicated in parenthesis) on femur, genu, tibia, and tarsus (excluding the minute tarsal unguinal setae, which flank pretarsi so closely as often to be indiscernible): leg I 4-4-6(2\( \phi \)) +7(1\( \omega \)); leg II 3-3-4-4(1\( \omega \)); leg III 1+3-4-4; leg IV 1+1-1+1. Subunguinal seta simple spinelike on tarsi of legs I-III. Minute paired unguinal setae \( u'-u'' \) flanking base of pretarsus of leg I; unguinal seta \( u'' \) present, but \( u' \) absent, distally on tarsi II and III.

Femur I with seta \( d \) slightly thicker than other setae apically. Tibia I sensory cluster with 2 solenidia, each 2.5-4 (3.0) \( \mu \text{m} \) long, \( \phi _1 \) slender and clavate at apex, \( \phi _2 \) stout and broadly clavate, well removed from \( k \); eupathid \( k \) 4-6 (4.8) \( \mu \text{m} \) long, rodlike, untapered, almost imperceptibly enlarged at tip. Tibiotarsus I with \( \omega \) clavate, 4-5 (4.9) \( \mu \text{m} \) long; larger than \( \phi _1 \) and \( \phi _2 \), eupathidia \( tc \) and \( p \) dissimilar in length: \( p \) longer than \( tc \), \( p'' \) longest, \( tc' \) and \( tc'' \) subequal in length, shortest, \( p' \) intermediate; only 2 setiform setae present on tarsal portion of segment, \( pv' \) slightly longer than \( pv'' \). Leg II with \( l'' \) longest on femur, genu and tibia. Femur II with 3 setiform setae, \( d, l' \) and \( l'' \). Tibia II with \( v', v'' \) and \( d \) subequal, attenuate. Tarsus II with 3 setiform setae, \( d \) longest, lacking \( pv'' \) and \( pl'' \); solenidion \( \omega \) clavate, 3.5-5 (4.3) \( \mu \text{m} \), slightly shorter than on leg I. Femorogenu III with 4 setae; tarsus III with 3 setiform setae, lacking \( pv'' \), and with \( d \) longest, attenuate, as on tarsus II. Femorogenu IV with genual seta 13-14 (13.4) \( \mu \text{m} \), stouter and longer than femoral setae. Tibiotarsus IV with tibial seta \( v' \) 28-32 (29.4) \( \mu \text{m} \), stout, smooth, slightly shorter than femorogenu; apical tarsal seta \( d \) very long, 87-95 (91.7) \( \mu \text{m} \), attenuate, smooth.

Length of idiosoma 185-218 (196.8) \( \mu \text{m} \), width 95-130 (113.5) \( \mu \text{m} \) (10 specimens).
FIGURE 1. *Tarsonemus parawaitei* sp. nov. Adult female, dorsal view. Setal, cupular and tergital notation explained in text. dg, dorsal gnathosomal setae; pp, postpalpal setae; ap pd, prodorsal apodeme.
FIGURE 2. *Tarsonemus parawaitei* sp. nov. Adult female, ventral view. Setal notation explained in text. ap I, apodeme I, ap II, apodeme II, ap III, apodeme III, ap IV, apodeme IV; ap sj, sejugal apodeme; tg, tegula.
FIGURES 3-6. *Tarsonemus parawaitei* sp. nov. Adult female: 3, leg I, lateral view; 4, leg II, lateral view; 5, leg III, dorsal view; 6, leg IV, dorsal view. Setal notation explained in text.
FIGURE 7. Tarsonemus parawaitei sp. nov. Adult male, dorsal view. Setal, cupular and tergital notation explained in text. ap pd, prodorsal apodeme.
FIGURE 8. *Tarsonemus parawaitei* sp. nov. Adult male, ventral view. Setal notation explained in text. ap pr, prosternal apodeme; ap sj, se jugal apodeme; ap po, poststernal apodeme; ge ca, genital capsule.
FIGURES 9-12. *Tarsonemus parawaitei* sp. nov. Adult male: 9, leg I, lateral view; 10, leg II, lateral view; 11, leg III, dorsal view; 12, leg IV, lateral view. Setal notation explained in text.
FIGURE 13. Tarsonemus parawaitei sp. nov. Larval female, dorsal view. Setal, cupular and tergital notation explained in text.
FIGURE 14. Tarsonemus parawaitei sp. nov. Larval female, ventral view. Setal, cupular and tergital notation explained in text.
FIGURES 15-17. *Tarsonemus parawaitei* sp. nov. Larval female: 15, leg I, dorsal view; 16, leg II, dorsal view; 17, leg III, dorsal view. Setal, cupular and tergital notation explained in text.
FIGURE 18. Tarsonemus parawaitei sp. nov. Larval male, dorsal view. Setal, cupular and tergital notation explained in text.
FIGURE 19. *Tarsonemus parawaitei* sp. nov. Larval male, ventral view. Setal, cupular and tergital notation explained in text.
FIGURES 20, 21. Tarsonemus parawaitei sp. nov. 20, egg outline; 21, larva inside female body, ventral view (note: venter of larva facing dorsal side of adult female).
FIGURE 22. *Tarsonemus parawaietei* sp. nov. Pharate female inside larval and nymphal apodermal cuticles (before being carried by adult male), ventral view. tg, tegula.
FIGURE 23. *Tarsonemus parawaitei* sp. nov. Pharate male inside larval and nymphal apodermal cuticles, ventral view. ap pr, prosternal apodeme; ap sj, sejugal apodeme; ap po, poststernal apodeme; ge ca, genital caps.
Adult male (Figs 7-12)

Gnathosoma (Figs 7, 8). with proportions, setation, palpal, cheliceral and pharyngeal structures as for female, but ventral apodemes weakly developed.

Dorsal idiosoma (Fig. 7). Dorsal shields unornamented. Prodorsal shield weakly sclerotized, subtriangular, width 62-77 (68.7) μm, length 41-50 (45.8) μm, i.e., 1.3-1.7 (1.5) times as wide posteriorly as long. Prodorsal setae slightly barbed; $\nu_1$ 25-29 (26.2) μm, $\nu_2$ 18-21 (19.6) μm (one specimen with an extra $\nu_2$ on one side of prodorsal shield); scapulars $sc_1$ the longest idiosomal setae, 60-67 (63.5) μm, less than twice the transverse distance between their bases, and less than posterior width of prodorsal shield; $sc_2$ 19-24 (21.7) μm inserted posterolateral of $sc_1$ but not in oblique longitudinal alignment with $\nu_1$, $\nu_2$, $sc_1$. Metapodosomal plate CD with setae slightly barbed; $c_1$ and $d$ stout, weakly tapered, with $c_1$ located anterolateral to $d$, $c_1$ 19-22 (21.0) μm, $c_2$ 28-35 (30.8) μm, slender, attenuate, $d$ 17-23 (19.8) μm; cupules $ia$ posteromedial of setae $c_1$ and anteriad of $d$. Subterminal tergite EF with cupules $im$ anterolateral of and adjacent to setae $e$ (by less than one alveolar diameter of $e$); setae $e$ 11-14 (12.7) μm, similar in shape to $c_1$ and $d$. Genital capsule heart-shaped in dorsoventral view, 26-28 (26.9) μm long by 23-27 (25.0) μm wide; setae $ps$ minute but discernible.

Ventral idiosoma (Fig. 8). Prosternal apodeme extending from its union with apodemes I to unite with sejugal apodeme, but interrupted at level of medial extremities of apodemes II, which are slightly expanded on anterior face. Sejugal apodeme not interrupted as in female. Coxal setae $Ia$ 9-10 (9.7) μm, inserted slightly behind apodemes I anteriad of their junction; $2a$ 11-15 (12.8) μm, inserted well behind apodemes II; coxal pits $Ib$ and $2b$ located far laterad of setae $Ia$ and $2a$, respectively. Coxisternal plates I and II unornamented except for a transverse band of fine puncta across posterior half of plates II. Poststernal apodeme well developed, divergent posteriorly at slightly more than half to two-thirds of its length, the branches well developed initially but vestigial in posterior portion. Apodemes III and IV well developed; anterior extremity of apodemes III weakly developed, connected to extremity of apodemes IV; anterior extremity of apodemes IV reduced, not connecting with poststernal apodeme. Coxal setae $3a$ 16-19 (17.6) μm, inserted behind anterior extremity of apodemes III; setae $3b$ 14-19 (17.1) μm, inserted slightly laterad of apodemes IV. Coxisternal plates IV, and less discernibly III, ornamented with fine, broken longitudinal striae; metapodosomal ventral plate ornamented with fine puncta laterally and in posterior half of area anterior to coxisternal plates III and
IV, but apparently lacking ornamentation near anterior margin and laterad of coxisternal plates III.

*Legs* (Figs 9-12). Leg length (excluding trochanters): I 48-55 (52.0) μm, II 48-52 (50.6) μm, III 50-59 (55.6) μm; leg IV (excluding trochanter and tarsal claw) 45-62 (53.2) μm, shorter or longer than, or subequal to leg III. Trochanters III and IV punctate dorsally. Number of setae and solenidia (indicated in parentheses) on femur, genu, tibia, and tarsus (excluding the minute tarsal unguinals): leg I 4-4-6(1φ)-8(1ω); leg II 3-3-4-4(1ω); leg III 1-3-4-3; leg IV 1+2-1(1φ)-3. Leg I with claw, tarsal solenidion, and other setation as in female except for a short seta ft' (but not ft") added near solenidion ω, one less Tibial solenidion, and eupathidia p" and tc" similar in length and longest, tc' shortest and p' intermediate on tarsus. Leg II with claws and setation as in female, except ω longer, 5-6 (5.1) μm and more broadly clavate, and both u' and u" present on tarsus. Leg III with claws and setation as in female except with only two setiform setae on tarsus (pv' absent), and with several setae differing in length, notably v" and d of tibia longer; very fine apical setae u' and u" discernible at base of apotele (not included in setal counts above). Leg IV moderately elongate, slender. Trochanter subquadrate, much wider than long. Femorogenu length 2.5-2.8 times its greatest width (this ratio sometimes distorted in artificially flattened specimens), with anterolateral margin almost straight as in Fig. 12, or slightly curved; posterolateral margin gently arched, without any flange or projection; femoral seta v' slender, short, 7-10 (8.4) μm; genual seta v' stout, slightly barbed, 16-23 (20.4) μm; dorsal genual seta l" slender, 19-28 (23.7) μm. Tibia usually elongate, 1.8-2.3 (1.9) times as long as wide, with a slender, rodlike solenidion 5-6 (5.1) μm and an attenuate, slightly barbed tactile seta 70-80 (75.5) μm, longer than entire leg. Tarsus short, with 3 small setae similar in length; tarsal claw slender, 8-13 (11.3) μm.

Length of idiosoma 140-153 (147.0) μm, width 75-93 (84.0) μm (10 specimens).

**Larval female** (Figs 13-17)

*Gnathosoma* (Figs 13, 14). Gnathosoma similar in structure to that of adult, except postpalpal setae absent and ventral apodemes not discernible.

*Dorsal idiosoma* (Fig. 13). Dorsal shields weakly sclerotized, smooth, unmarked except for a pair of weakly defined lateral sutures extending obliquely from near anterior quarter of tergite C posterolaterally to beyond base of setae cI. Dorsal soft cuticle plicate. Prodorsal shield 46-56 (51.2) μm by 56-60
(58.0) μm, (i.e. 1.0-1.2 times as wide posteriorly as long medially); anterior margin slightly rounded, not extending over gnathosoma. Prodorsum with setae \( v_1 \) and \( sc_1 \) subequal in length, each 17-21 (18.8) μm; setae \( sc_2 \) 58-65 (61.7) μm, 3.2-3.5 times as long as \( sc_1 \), and also longer than any tergital setae. Pits \( v_2 \) located near anterolateral margin of prodorsal shield, nearly midway along interval between bases of setae \( v_1 \) and \( sc_1 \). Transverse interval between bases of setae \( sc_2 \) 32-37 (33.5) μm, between pits \( v_2 \) 28-30 (28.8) μm, between setae \( sc_1 \) 37-41 (38.5) μm. All prodorsal setae attenuated and smooth except for slightly barbed basal part of setae \( sc_2 \); tergital setae \( c_2 \) attenuated and smooth but all other tergital setae slightly barbed, and weakly tapered except for \( h_1 \). Tergite C with setae \( c_1 \) inserted close to its posterior margin. Tergite EF with setae \( e \) inserted well anterolateral of transverse alignment with \( f \). Tergital setal lengths: \( c_1 \) 11-13 (12.4) μm, \( c_2 \) 15-18 (17.0) μm, \( d \) 21-23 (22.0) μm, \( e \) 21-23 (22.0) μm, \( f \) 26-27 (26.7) μm, \( h_1 \) 48-58 (53.2) μm, \( h_2 \) 15-17 (16.3) μm. Cupules \( ia \) anterolateral of setae \( d \), \( im \) laterad of and slightly posterior to setae \( e \), and \( ih \) midway between \( h_1 \) and \( h_2 \), or slightly closer to \( h_1 \).

**Ventral idiosoma** (Fig. 14). Prosternal apodeme well developed from its union with apodemes I to level of posterior margin of coxisternal plates II, weakening posteriorly from level of medial extremities of apodemes II. Apodemes II not connected with prosternal apodeme; sejugal apodeme absent. Coxal setae \( 1a \), \( 2a \) and pits \( 1b \), \( 2b \) in form and position about as for adult male, except \( 1a \) slightly further behind apodemes I. Coxisternal plates III roughly rectangular, 39-43 (41.2) μm long by 19-20 (19.5) μm wide, bearing setae \( 3a \), \( 3b \) and medially broadly separated by plicate soft cuticle. Consolidated caudal capsule HPS with 2 pairs of small \( ps \) setae 6-9 μm long flanking uropore ventroterminally.

**Legs** (Figs 15-17). Leg length (excluding trochanters): I 43-46 (44.2) μm, II 40-43 (41.7) μm, III 40-42 (41.0) μm; apoteles with paired claws well developed on all legs. Number of setae and solenidia (indicated in parentheses) on femur, genu, tibia, and tarsus (excluding the minute tarsal unguinals): leg I 4-4-6(0)-5(1ω); leg II 3-3-4-3(1ω); leg III 1-3-4-3. Setae absent on larva and expressed subsequently in adult: solenidia \( φ \) on tibia I, eupathidia \( tc'-tc'' \) on tarsus I, and \( pv' \) on tarsi II and III. Tibia I with eupathid \( k \) slightly lanceolate near tip, as for adult; tarsus I with eupathidia \( p' \) and \( p'' \) similar in length; \( d \) on femur I and \( l' \) on genu II setiform, similar to other setae. Very fine, paired unguinal setae \( u'-u'' \) (not included in setal counts above) barely discernible on tarsi I and II but longer and more discernible on tarsus III.
Length of idiosoma 168-190 (176.0) μm, width 85-93 (90.3) μm (6 specimens).

**Larval male** (Figs 18, 19)

As for larval female except with three pairs of ps setae instead of two pairs, and prosternal apodeme not as well developed, interrupted at medial extremities of apodemes II.

Length of idiosoma 188-205 (196.5) μm, width 98-108 (103) μm (2 specimens).

**Egg** (Fig. 20)

Elongate oval, some faint reticulate patterns on its surface. Length 102 μm; width 58 μm.

**Material examined**

**Holotype** ♀, NEW ZEALAND, Central Otago, Alexandra, 53 Shannon St. (abandoned property), 15.x.1997, C. Brown & R. Adams (97-1706), ex dried apricot fruit (NZAC). **Paratypes.** NEW ZEALAND: 18 ♀ ♂, 1 pharate ♀ and 1 pharate ♂ on same slide, 7 larval ♀ ♀, 2 larval ♂ ♂, 3 larvae (sex uncertain), 1 larva inside female body, same data as holotype (NZAC); 1 ♀, 1 ♂, 1 larval ♀, same data as holotype (CNCI); 1 ♀, 1 ♂, 1 larval ♀, same data as holotype (UQBA); 2 ♀ ♀, Central Otago, Clyde Research Centre, ii.1997, G.F. McLaren, ex Fantasia nectarine, white peach (NZAC); 4 ♀ ♀, 4 ♂ ♂, 2 pharate ♀ ♀, Central Otago, K. Paulin’s orchard, 21-26.i.1997, G.F. McLaren, ex apricot (NZAC); 7 ♀ ♀, 4 ♂ ♂, Central Otago, K. Paulin’s orchard, 23.i.1997, G.F. McLaren, ex stems and old flower parts of fruit of Sundrop apricot (NZAC); 2 ♀ ♀ on one slide, Central Otago, Roxburgh East, P. Gilchrist’s orchard, 8.xi.1996, G.F. McLaren, ex apricot trees (CNCI). AUSTRALIA: 1 ♀ and 1 ♂ on one slide, Victoria, Monash University, 2.x.1990, D.E. Walter, ex Cladosporium fungal culture (CNCI), 2 ♀ ♀ and 1 larval ♀ on one slide, Victoria, Clayton, 2.xi.1990, D.E. Walter, ex Viburnum tinus leaf domatia (CNCI). ITALY: 1 ♀, 1 larva sex uncertain, Reg. Puglia Palaggiano, 23.xi.1987, E. de Lillo, ex green fruit of Olea europaea (CNCI); 2 ♀ ♀ and 2 ♂ ♂ on one slide, Follonica (CNCI). FRANCE: 6 ♀ ♀ (3 per slide), Montpellier, v.1985, Poinso, ex gall with Eriophyidae on poplar leaves (CNCI).
Discussion

Taxonomic history

*Tarsonemus parawaitei* was first recorded in the literature by Karl (1965) as *T. setifer* (now a junior synonym of *T. waitei*, see Lindquist 1978). His specimens were found on ornamental plants in a greenhouse, and were identified by Dr L. Schaarschmidt (Göttingen) as *Tarsonemus setifer* Ewing. Karl also stated that Dr Schaarschmidt found a small distinction in the structure of the ambulacrum of leg I as compared to the figure given by Beer (1954, presumably plate 23), implying that Dr Schaarschmidt had already noticed a difference between Karl's specimens and *T. setifer*. However, no authentic specimens of *T. setifer* Ewing were available for them to compare. Lindquist (1978) recognised that *T. setifer* sensu Karl was an undescribed species and clearly distinguished it from *T. setifer* Ewing (=*T. waitei*). This species is now described and named in the present study.

Recorded distribution

Recorded from Germany, Italy, France, Australia, and New Zealand.

Feeding

*Tarsonemus parawaitei* has been found on ornamental plants in a glasshouse (Karl 1965), fruit and stems of apricot, Fantasia nectarine, leaf domatia of *Viburnum tinus*, and green fruit of *Olea europa*. Evidently, the mites feed primarily on fungi associated with the leaves or fruits of plants rather than on the plants themselves. We reared the mites from dry fruit of apricots, and found them able to survive on the dry fruits; when we increased the moisture, fungi grew, and mite numbers in every stage increased. Also, as noted in the collection data for type material of *T. parawaitei* above, the specimens obtained from D.E. Walter in Australia were taken from a culture maintained on fungi (confirmed by D. E. Walter, personal communication, January 1998). Fungivory has also been demonstrated for some other species of the *waitei*-group, as noted by Lindquist (1978). On the other hand, Karl (1965) observed that the damage caused to leaves of ivy plants by the obligately phytogaphagous *Polyphagotarsonemus latus* (Banks) was intensified by the presence of *Tarsonemus “setifer”* (= *T. parawaitei*). However, Karl's observations are inconclusive as he had no observations of damage caused to plants by *T. parawaitei* alone. Nevertheless, as reviewed by Lindquist (1978), there is
evidence that at least some species of the *waitei*-group are possibly facultatively phytophagous, and capable of causing distortive growth in their plant hosts. We agree with his conclusion that further ecological research on mites of this group and their possible economic importance on fruit crops is clearly needed.

*Life history and reproduction*

As in other Tarsonemidae, the life history stages of *T. parawaitei* includes egg, larva, calyptostase nymph (the apoderm), and adult. We confirmed the presence of an apodermal cuticle enclosing the pharate female and pharate male (Figs 22, 23), as discussed by Lindquist (1986a). We observed eggs in the culture medium, and also observed well-developed larvae inside adult females, some still in the egg shell (Fig. 21), and some without any shell and their legs fully extended. As shown in Fig. 21, females contain only one developing larva at a time. The extent to which this species may be able to employ ovipary and ovovivipary as alternative reproductive strategies requires further investigation.

*Number of solenidia on tibia I in adult male and female*

In the New Zealand material of *T. parawaitei*, there are two solenidia on tibia I of the female but only one in the male. We have also examined males and females from Australia and Italy and, again, the males had only one solenidion on tibia I but the females had two. We are confident about the conspecificity of the New Zealand males and females, as we have reared these mites in culture, and also have caught mating couples and made slides of them for confirmation. Whether this sexual dimorphism may be true for some other species of *Tarsonemus* or of other Tarsonemidae needs further investigation.

*Intraspecific variation or abnormality of adult male*

Two setae *v₂* were observed on one side of the prodorsum of one specimen, and two setae *e* on one side of another specimen. Also the length of leg IV is variable. Considerable intraspecific variability in size of leg IV has also been observed among males of *Tarsonemus waitei* and *T. nodosus* Schaarschmidt by Lindquist (1978) and Kaliszewski *et al.* (1983), respectively.

*Separation of larval male and female*

Lindquist (1986b) found that larval males and females of tarsonemids can be distinguished by the number of *ps* setae: males with three pairs and females with two pairs. This is true also for *Tarsonemus parawaitei*. 
Separation of Tarsonemus parawaitei from other species

Tarsonemus parawaitei can be separated from other similar species using Lindquist’s (1978) “Provisional key to species in the waitei group” with some modifications. Lindquist explained that the key was provisional because some character states of the species were based on published descriptions and illustrations rather than on examination of specimens. He specifically stated “The character states given for the adult male of the species misidentified by Karl (1965) as T. setifer are based on Karl’s illustrations.” One of the character states used in the key (couplet 3) for the adult is that both female and male of T. setifer sensu Karl (now = T. parawaitei) have two solenidia on tibia I. Our finding of consistent sexual dimorphism in the solenidia of tibia I, plus a few other observations for T. parawaitei, leads us to update Lindquist’s (1978) key, as follows.

Key to species in the waitei group

1. Larva and adult: tarsal seta pl present on leg I (figs. 2, 4, Suski 1965; fig. 10, Lindquist 1978); femur II with 3 setae; Adult female: poststernal apodeme well developed, bifurcate anteriorly (fig. 1A, Suski 1965); sejugal apodeme continuous, though sometimes slightly weaker medially; cupules ih nearly contiguous with setae h (fig. 1B, Suski 1965) .................................................. 2
   - Larva and adult: tarsal seta pl absent on leg I (Figs. 3, 9, 15); femur II with 2 or 3 setae; Adult female: poststernal apodeme reduced or absent, not bifurcate anteriorly (Fig. 2); sejugal apodeme interrupted medially and/or on either side of midline (Fig. 2); cupules ih well separated from setae h (Fig. 1) .................. 3
2. Adult female: scapular setae more than 1.5 times as long as transverse distance between their bases; setae c2 about 1.5 times as long as c1; Adult male: coxisternal plates I to III tuberculate, and IV striate; tarsus I lacking 1 of the 2 small fastigial setae (ft’) near solenidion; setae c1 and c2 each about one-third longer than d (fig. 10, Lindquist 1978)................................. T. bakeri Ewing
   - Adult female: scapular setae apparently about as long as transverse distance between their bases; setae c2 apparently only slightly longer than c1 (fig. 1B, Suski 1965); Adult male: coxisternal plates I to IV apparently weakly tuberculate, but IV not striate (fig. 3A, Suski 1965); tarsus I with both of the 2 small fastigial setae near solenidion (fig. 4, Suski 1965); setae c1 and c2 subequally as long as d (fig. 3B, Suski 1965) ......................... T. lobosus Suski
3. Larva and adult: femur II with 3 setae (Figs. 4, 10, 16); Adult female: tergital setae d and e slender and tapered like c1 (Fig. 1); tibial sensory cluster of
leg I with 2 solenidia in addition to eupathid k (Fig. 3); Adult male: sejugal apodeme continuous (Fig. 8) .................................. T. parawaitei sp.nov.

- Larva and adult: femur II with 2 setae (figs. 1, 2, 9, Lindquist 1978); Adult female: tergal setae d and e similar in form to f and h, slightly thicker and less tapered than c1 (fig. 1, Lindquist 1978); tibial sensory cluster of leg I with 1 solenidion in addition to eupathid k (figs. 5A, 5C, Suski 1968); Adult male: sejugal apodeme interrupted on either side of midline (fig. 2, Lindquist 1978; fig. 3A, Suski 1968) .......................................................... 4

4. Adult female: sejugal apodeme well developed and continuous except near midline (fig. 1, Lindquist 1978); scapular setae over twice as long as transverse distance between their bases, and 3 times as long as vertical setae; setae c1 usually slightly longer than e, and slightly shorter than f (fig. 1, Lindquist 1978); Adult male: coxisternal plates IV, and sometimes III, striate (fig. 2, Lindquist 1978); tarsus I lacking 1 of the 2 small fastigial setae (ft') near solenidion (fig. 2, Lindquist 1978); leg IV with tibial tactile seta longer than length of entire leg (figs. 2-7, Lindquist 1978) .............................................

.................................................. T. waitei Banks (=setifer Ewing, = pauperoseatus Suski)

- Adult female: sejugal apodeme obscure along most of its length, leaving two widely-spaced, well-developed remnants laterally (fig. 1A, Suski 1968); scapular setae apparently about 7/4 as long as transverse distance between their bases, and about 2.5 times as long as vertical setae; setae c1 apparently subequally as long as e and f (fig. 1B, Suski 1968); Adult male: coxisternal plates III and IV apparently unornamented (fig. 3A, Suski 1968); tarsus I with both of the small fastigial setae near solenidion (fig. 5C, Suski 1968); leg IV with tibial tactile seta shorter than length of femorogenu (fig. 4, Suski 1968) ....... T. idaeus Suski

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