CITRUS MITES IN ITALY. VII. THE FAMILY TARSONEMIDAE. SPECIES COLLECTED AND NOTES ON ECOLOGY

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TARSONEMIDAE
CITRUS
ITALY

SUMMARY: The study deals with the complex of species belonging to the family Tarsonemidae Canestrini and Fanzago, collected in various periods on the most important *Citrus* species in the principal Citrus growing areas in Italy. The morphology of each species was studied, and each species was classified in agreement with the systematic view expressed by LINDQUIST (1986). The study involved the collection of twelve species, eleven of which belong to the subfamily Tarsoneminae and to the tribe Tarsonemini. Of the collected Tarsonemini, nine species were assigned to the genus *Tarsonemus* Canestrini and Fanzago 1876 and to the subgenus *Tarsonemus* Canestrini and Fanzago (*T. smithi* Ewing, *T. aurantii* Oudemans, *T. confusus* Ewing, *T. parawaitei* Kim, Qin and Lindquist, *T. waitei* Banks, *T. floricolus* Canestrini and Fanzago, *T. idaeus* Suski, *T. bilobatus* Suski and *T. lobosus* Suski), one to the genus *Daidalotarsonemus* De Leon 1956 (*D. vandevriei* Suski), and one to the genus *Fungitarsonemus* Cromroy 1958 (*F. monasterii* (Lombardini)). The only Pseudotarsonemoidine was assigned to genus *Polyphagotarsonemus* Beer and Nucifora 1965 (*P. latus* (Banks)). The given list of Tarsonemini does not include *T. bakeri* Ewing 1939 and *T. unguis* Ewing 1939, previously mentioned by the authors in relation to *Citrus* in Italy (VACANTE & NUCIFORA, 1985), on account of the fact that the authors have subsequently verified that the specimens identified as *T. bakeri* belong to the *species T. waitei* and the ones identified as *T. unguis* are *T. floricolus*. Instead, the authors report four new records (*T. floricolus*, *T. idaeus*, *T. bilobatus* and *T. lobosus*) on citrus in Italy.

Recently, NUCIFORA & VACANTE (in press) published a list of Tarsonemids inhabiting *Citrus* plants in Italy and yielded a total of 12 species. According to LINDQUIST (1986) eleven belong to the subfamily Tarsoneminae, to the tribe Tarsonemini and to the genera *Tarsonemus* Canestrini and Fanzago 1876 (*T. smithi* Ewing, *T. aurantii* Oudemans, *T. confusus* Ewing, *T. parawaitei* Kim, Qin and Lindquist, *T. waitei* Banks, *T. floricolus* Canestrini and Fanzago, *T. idaeus* Suski, *T. bilobatus* Suski and *T. lobosus* Suski), *Daidalotarsonemus* De Leon 1956 (*D. vandevriei* Suski), *Fungitarsonemus* Cromroy 1958 (*F. monasterii* (Lombardini)), whereas one species belongs to the subfamily Pseudotarsonemoidi-

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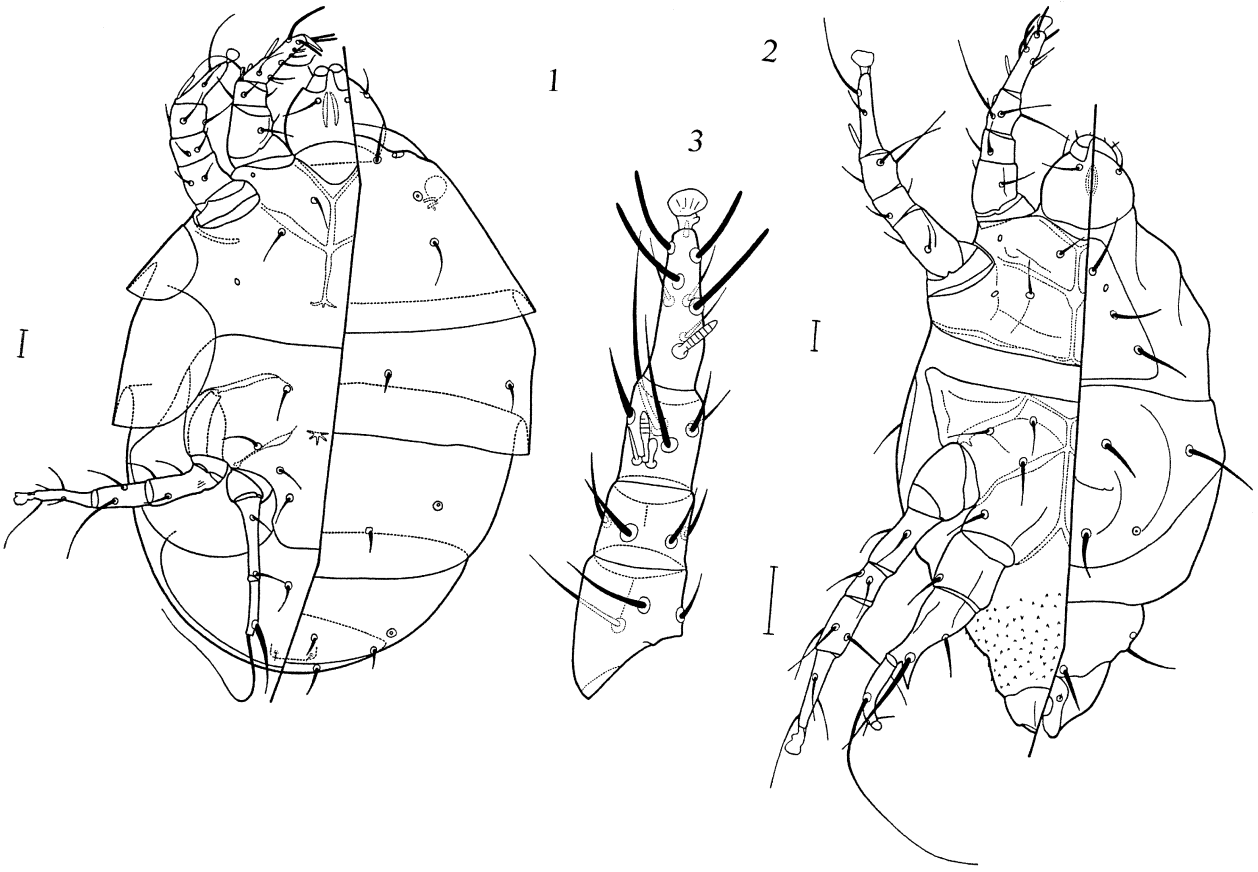


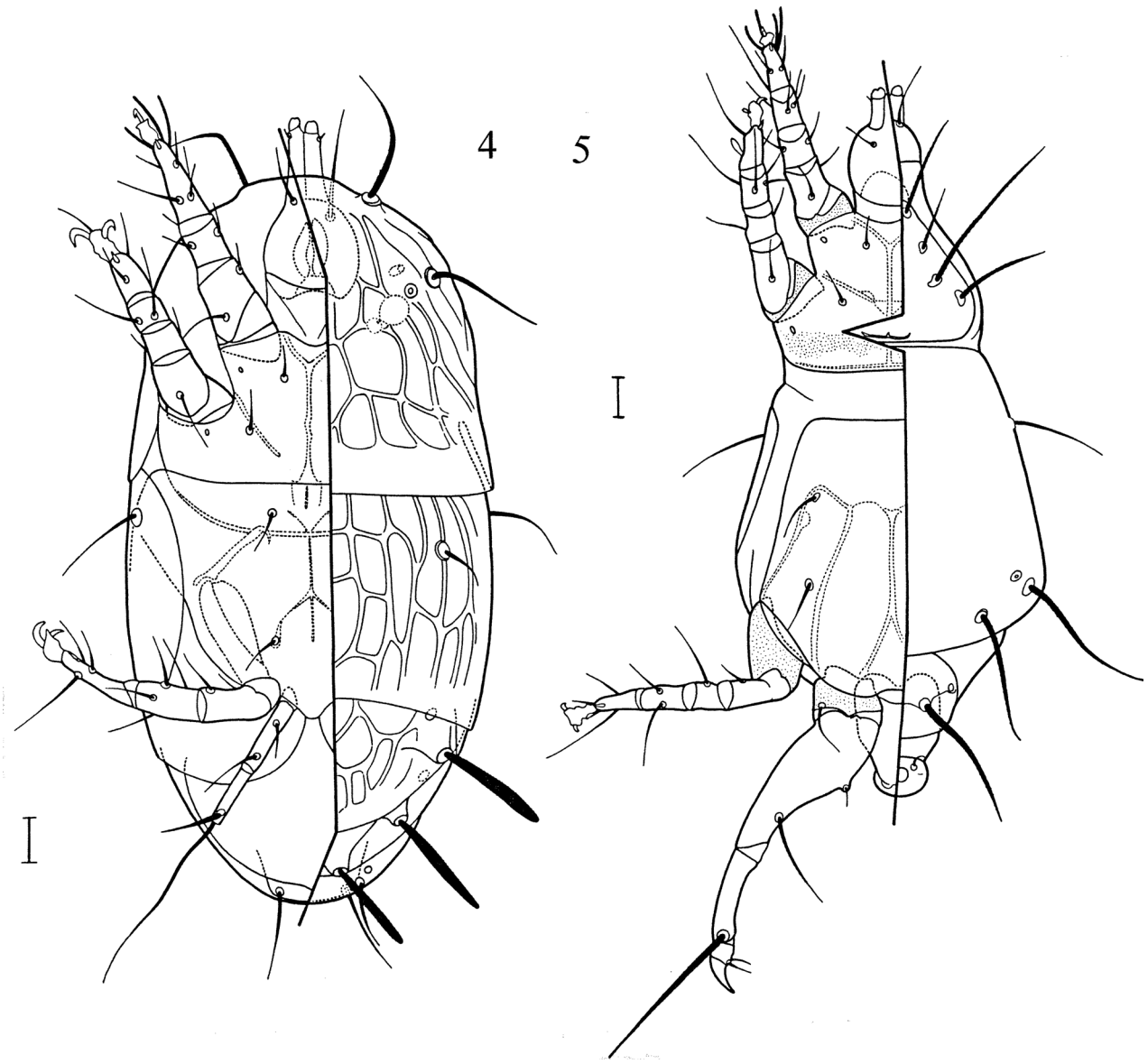
FIGS. 1-3. — *Polyphagotarsonemus latus* (Banks), dorsal view (on the right) and ventral view (on the left) of female (1) and male (2), leg I of male (3). The scale bars correspond to 10 μm.

nae, to the tribe Pseudotarsonemoidini and to the genus *Polyphagotarsonemus* Beer and Nucifora 1965 (*P. latus* (Banks)). The list containing the 12 species contains neither *T. bakeri* Ewing 1939 nor *T. unguis* Ewing 1939, formerly recorded for *Citrus* in Italy (VACANTE & NUCIFORA, 1985), on account of the fact that the authors have subsequently verified that the specimens identified as *T. bakeri* belong to the species *T. waitei* and the ones identified as *T. unguis* are *T. floricolus*.

This contribution presents an identification key for the 12 collected species, integrated with genera and subgenera fundamentally draft by LINDQUIST (1986). For each species, we present brief ecological notes based on literature and personal experiences of the present authors.

MATERIAL AND METHODS

The research has carried out in the principal citrus growing. It randomly sampled in different months of the year and on the principal species and variety of *Citrus* leaves, fruits, twigs and bark. The sampled material was observed in the laboratory with a stereomicroscope and the mites collected were prepared and mounted on slides. In particular, the Tarsonemids were first washed in distilled water, subsequently mounted on slides with polyvinyl alcohol (PVA) and dried in a heater to 30° C. The species *F. monasterii* was not been collected and the study was carried out on five samples (three ♀♀ and two ♂♂) mounted on two slides prepared by LOMBARDINI (1959) and



FIGS. 4 and 5. — *Daidalotarsonemus vandevriei* Suski, dorsal view (on the right) and ventral view (on the left) of female (4) and male (5). The scale bars correspond to 10 μm.

donated to the authors by prof. S. RAGUSA of Palermo University (Italy). A differential interference contrast microscope (Zeiss Axioplan) operating in immersion was used for the morphological examination. All specimens are deposited in the VACANTE collection.

KEY FOR THE IDENTIFICATION
OF THE GENERA, SUBGENERA AND SPECIES
(derived partly from LINDQUIST, 1986)

1. Metapodosomal venter of male and female with 3 or 4 pairs of setae, including 1 pair of setae located between the legs IV of the female or the coxal plates IV of the male; leg I of the female with membranous parts of the ambulacrum reduced or absent, with wide claw, nearly sessile or rarely absent 2
— Metapodosomal venter of both the male and the female with 2 pairs of setae, none of them between the bases of legs IV of the female nor on the coxal plates IV of the male; leg I of the female with membranous ambulacrum and often with small or reduced claw..... 3
2. Female with prodorsal shield not-extended beyond the stigmata, with opening on the dorsolateral margin slightly before the vertical setae, small dorsal setae, sca-

pular longer than any other dorsal setae, tibiotarsus of leg IV with 2 setae; the male without prodorsal seta v_2, with leg IV having triangular flange, pointed, located distally on posterolateral surface of the femorogenu, and terminal claw reduced and buttonlike (genus ***Polyphagotarsonemus***); femur I of male and female with 3 setae . . . . . ***P. latus*** (figs. 1-3)

3. Female with prodorsal shield, hoodlike with lateral margins emarginated at level of stigmata, prodorsum and tergites C, D and EF strongly reticulated (genus ***Daidalotarsonemus***); female with dorsal setae sc_2 and c_2 tapering, setae *d*, *e* and *f* arranged on tubercles well pronunced, slightly barbed and clavate . . . . . ***D. vandevriei*** .(figs. 4 and 5)

— Female with prodorsal shield also indented, but not emarginated at level of the stigmata, body dorsally smooth or with fine puncta or sometimes striae . . . 4

4. Female with scapular setae inserted beside the stigmata, anteriad of pits v_2 and on the anterior half of the prodorsal shield; leg IV of male long, slender, with femorogenu at least 4 times longer than the greatest width, trochanter with or without seta (genus ***Fungitarsonemus***); male with long prodorsal setae sc_1 approximately double the histerosomal setae c_2, tarsus II with solenidion about 3 times longer then the width of the basis . . . . . ***F. monasterii*** (figs. 6-8)

— Female with scapular setae inserted posteriad to pits v_2 and stigmata, usually about at half length, or on the posterior half of the prodorsal shield; femorogenu of leg IV of male at least 3 times longer than the maximum width, trochanter with 1 seta: genus ***Tarsonemus***. . . 5

5. Female with femorogenu of leg III immovably connected to tibia, scapular setae inserted into the anterior half of prodorsal shield; male with femur of leg III immovably connected to the genu, femorogenu of leg IV with keel-shaped flange, tarsal claw flattened . . . . . subgenus ***T.*** (***Floridotarsonemus***) [1]

— Female with femorogenu of leg III freely articulating with the tibia, scapular setae inserted at half length or at posterior half of the prodorsal shield; male with femur of leg III freely articulating with the genu, femorogenu of leg IV without flange or with differently formed flange, tarsal claw normal and unguiform. . 6

6. Female with prodorsal bothridial seta setiform, apodemes I consolidated into rounded projection, convex and partly underlying trochanters I and base of the gnathosoma; male with femorogenu of leg IV with rounded flange and fused tibiotarsus . . . . . subgenus ***T.*** (***Chaetotarsonemus*** [1])

— Female with prodorsal botridial setae that are almost always capitate, apodemes I not consolidated into convex projection; male with femorogenu of leg IV without flange or with small flange of another form, tibia and tarsus separated or fused . . . . . subgenus ***T.*** (***Tarsonemus***) 7

7. Tarsus II of both male and female with spinelike seta *pl″* (figs. 11, 14, 17 and 20) 8

— Tarsus II of both male and female without seta *pl″* (figs. 22, 25, 28, 31 and 35) 11

8. Female with sejugal apodeme with a double arc-shaped median part; male with apodeme III definitely arched, mediodistal area of coxisternal plates IV next to poststernal apodeme finely punctuated, apodeme IV and trochanter III finely punctuated, solenidion ω of leg II as long as the maximum width of tarsus . . . . . ***T.*** (***T.***) ***confusus*** (figs. 9-11)

— Female with sejugal apodeme divided or entire, never with a double arc-shaped median part; male with apodeme III not arched, puncta variously distributed, solenidion ω of leg II of various length, but not as long as the max width of tarsus 9

9. Male and female with entire sejugal apodeme; male with fine puncta on the coxisternal plate II, uniform and placed anteriorly to sejugal apodeme, area of ventral metapodosomal plate adjacent at apodeme III with fine puncta, coxisternal plates III and IV without puncta and anteriorly delimitated by apodemes III and IV, more or less right . . . . . ***T.*** (***T.***) ***smithi*** (figs. 12-14)

— Female with sejugal apodeme of various shape; male with coxisternal plates III and IV variously punctuated, but not as above 10

10. Female with sejugal apodeme divided in three parts of which the median is the smallest of the three; male with divided sejugal apodeme, metapodosomal plate CD punctuated at the distal end, mediolateral area of the coxisternal plate II slightly punctuated, mediodistal areas of the coxisternal plates IV finely punctuated adjacent to the poststernal apodeme, leg II with solenidion smaller than the maximum tarsal width . . . . . ***T.*** (***T.***) ***floricolus*** (figs. 15-17)

— Female with sejugal apodeme divided in two distinct halves each of which originates at the prosternal apodeme and is curved towards the exterior forming a typical lobe; male with entire sejugal apodeme, with metapodosomal plate CD not punctuated, coxisternal plates I and II irregularly punctuated, coxisternal plates III and IV with striae, area of the ventral metapodosomal plate adjacent at the apodeme III finely punctuated, solenidion of leg II larger than the tarsal width. . . . . ***T.*** (***T.***) ***bilobatus*** (figs. 18-20)

11. Male and female with femur II carrying 2 setae (figs. 22 and 25) 12

1. The systematic categories marked with [1] have not been collected but are listed to facilitate understanding of the key.

— Male and female with femur II carrying 3 setae (figs. 28, 31 and 35) 13

12. Female sejugal apodeme divided in two lateral parts, and not interconnected in the median position .... ***T.*** (***T.***) ***idaeus*** (figs. 21 and 22)

— Female with sejugal apodeme divided in three parts of which the two lateral ones are wide and the median one is the smallest. ..... ***T.*** (***T.***) ***waitei*** (figs. 23-25)

13. Female tibia of leg I carrying 1 solenidion and 1 eupathidium (k) ..... ***T.*** (***T.***) ***lobosus*** (figs. 26-28)

— Female tibia of leg I carrying 2 solenidia and 1 eupathidium (k) (figs. 30 and 34) 14

14. Female with sejugal apodeme divided in three parts of which the lateral ones are wider than the median, tibiotarsus of leg I with 2 solenidia (φ_1 and φ_2) placed close together and 1 eupathidium (k) located behind, at a distance corresponding more or less to its length .... ***T.*** (***T.***) ***parawaitei*** (figs. 29-31)

— Female with entire sejugal apodeme, tibiotarsus of leg I with solenidion φ_1 and φ_2 and eupathidium k placed side by side. ..... ***T.*** (***T.***) ***aurantii*** (figs. 32-35)

Species collected and brief notes on ecology

Polyphagotarsonemus latus (Banks)

(figs. 1-3)

Tarsonemus latus Banks, in Banks N.,1904, Class III, Arachnida, Order I, Acarina, four new species of injurious mites. J. N. Y. Entomol. Soc., 12: 53.

Widespread species, common in tropical areas and in greenhouses located in temperate and subtropical zones, injurious and distributed on a wide variety of cultivated, ornamental, and wild plants including *Citrus* (Jeppson *et al*., 1975). In Italy the species is known as a pest of *Citrus* (Nucifora, 1961) and of vegetables growing either in greenhouses or in the open field (Nucifora, 1980; Vacante, 1989).

Daidalotarsonemus vandevriei Suski

(figs. 4 and 5)

Daidalotarsonemus vandevriei Suski, in Suski Z. W., 1967a, Tarsonemid Mites on Apple Trees in Poland. VIII. *Daidalotarsonemus vandevriei* n. sp. (*Acarina*, *Tarsonemidae*). Bull. Acad. Pol. Sci. Cl. V. ser. Sci. Biol., 15: 227.

The species is known in Holland, Poland (Suski, 1967a) and Italy (Vacante & Tropea Garzia, 1987). In Sicily and Calabria (Italy), it has been found on various *Citrus* species, where it inhabits the bark of large branches and lives among lichens serving as food.

In Poland, many females, eggs and larvae have been found on apple tree bark covered with a rich vegetation of algae and lichens, among them *Lepraria aeruginosa* (G. H. Web), *Xantoria* sp. (? *parietina*) and *Pleurococcus* sp.; laboratory work has indicated that the mite lives on these epiphytes and has ascertained that the clear presence of green pigment inside the body of larvae and adults indicates, in agreement with a hypothesis put forward by De Leon (1956) for two species of same genera, an adaptation at microphytophagy (Suski, 1967a).

Fungitarsonemus monasterii (Lombardini)

(figs. 6-8)

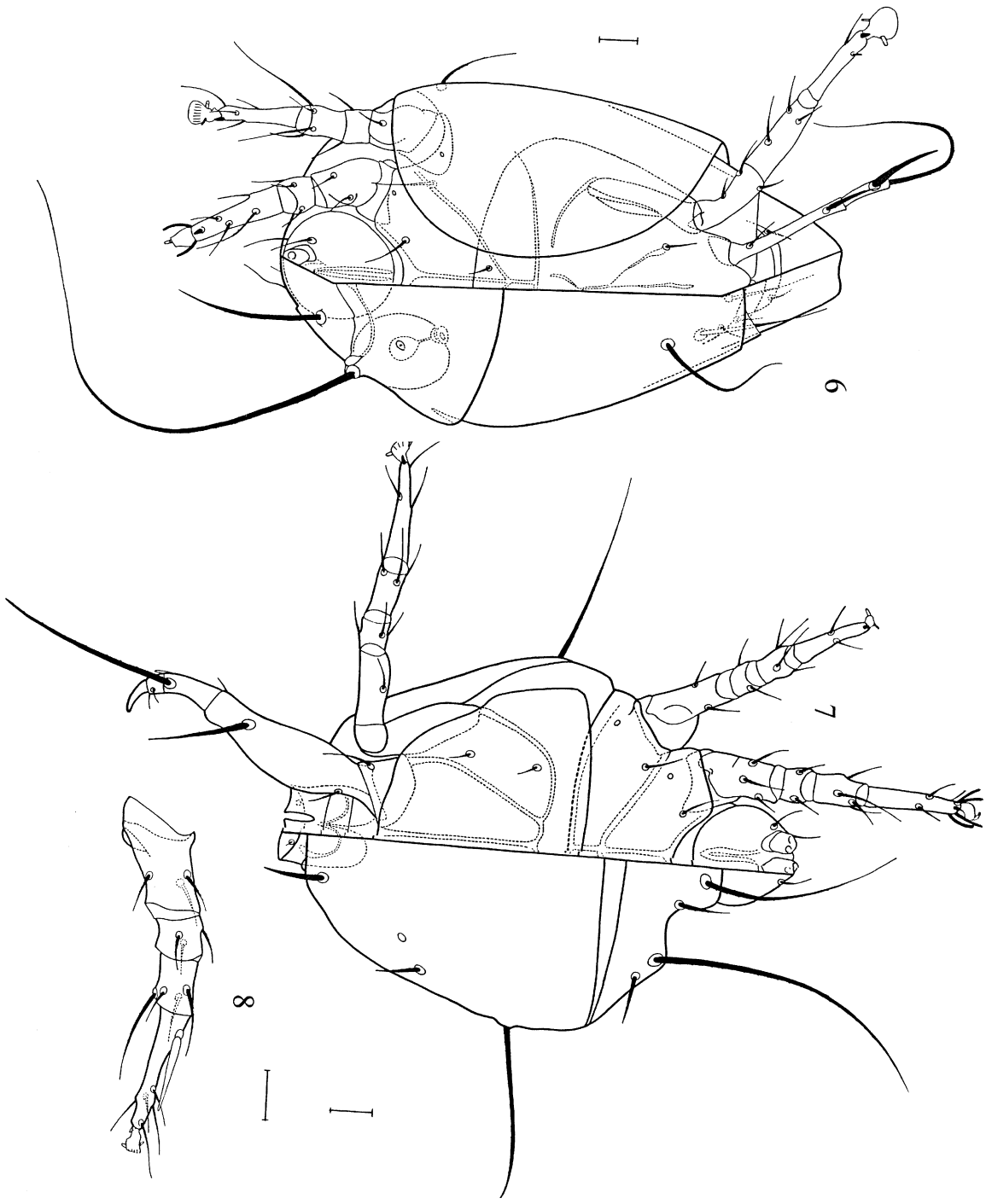
Hemitarsonemus monasterii Lombardini, in Lombardini G., 1959, Acari Nuovi. XXXVII. Boll. Ist. Ent. agr. Oss. Fitopat. Palermo, 3: 163.

As far as is known, *F. monasterii* has not been collected anywhere else and is consequently listed as a species exclusively inhabiting citrus plants in Sicily where, despite research aimed at its recovery in various locations in the province of Palermo including the area in which it was discovered for the first time as well as other locations in Sicily and continental Italy, no further specimens have been found. On the other hand, the incomplete description by Lombardini stresses the need re-description of its morphology (Vacante, in press). The mite is probably a fungus feeder.

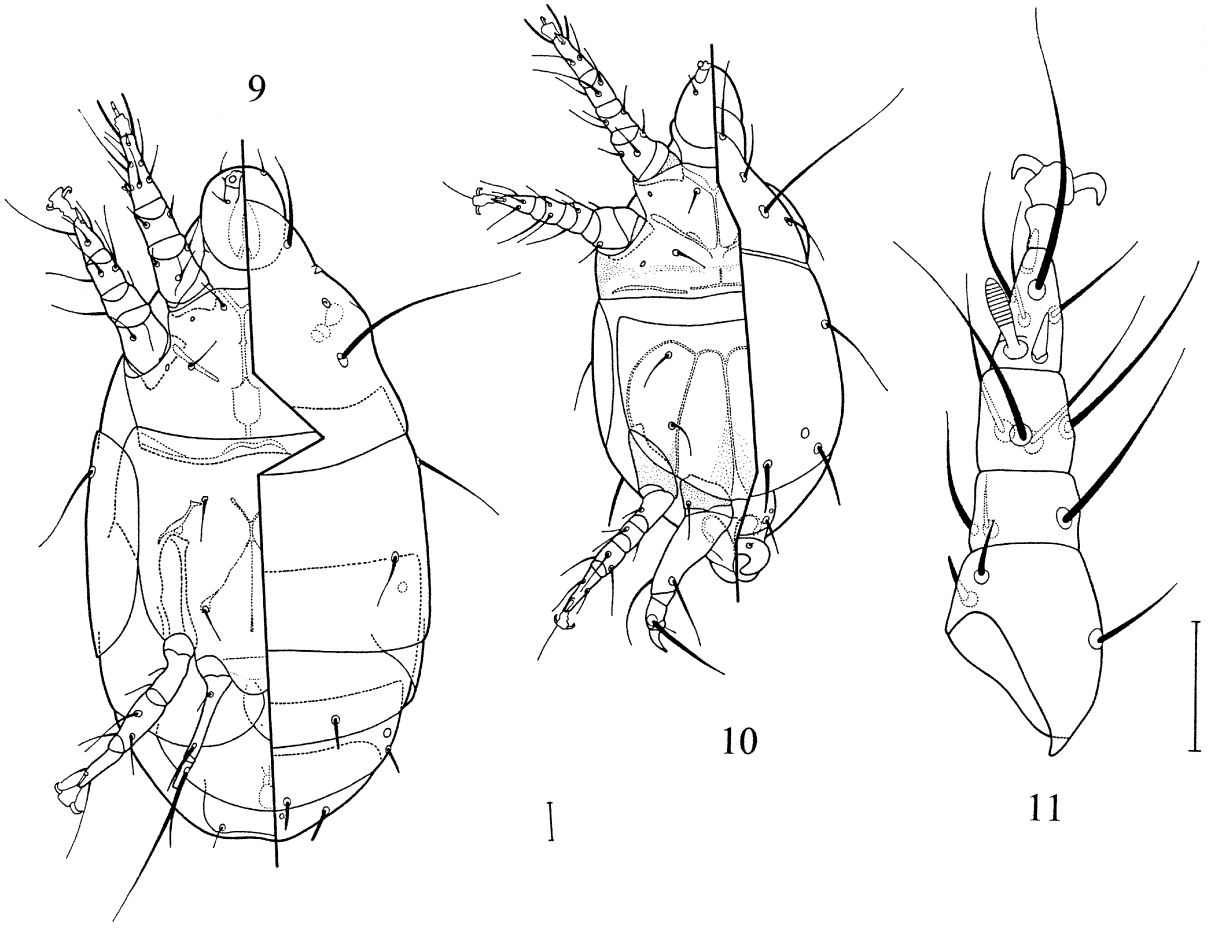
Tarsonemus* (*Tarsonemus*) *confusus Ewing

(figs. 9-11)

Tarsonemus confusus Ewing, in Ewing H. E., 1939, A revision of the mites of the subfamily Tarsoneminae of North America, the West Indies and the Hawaiian Islands. Tech. Bull. U.S. Dept. agric., 653: 26.



FIGS. 6-8. — *Fungitarsonemus monasterii* (Lombardini), dorsal view (on the left) and ventral view (on the right) of female (6), dorsal view (on the right) and ventral view (on the left) of male (7), leg II of male (8). The scale bars correspond to 10 μm.



FIGS. 9-11. — *Tarsonemus confusus* Ewing, dorsal view (on the right) and ventral view (on the left) of female (9) and male (10), leg II of male (11). The scale bars correspond to 10 μm.

The species has a widespread distribution and is known in the United States of America (EWING, 1939; BEER, 1954), Germany (SCHAARSCHMIDT, 1959; KARL, 1965), Japan (ITO, 1963), Poland (SUSKI, 1967b), Byelorussia (MITROFANOV & TREPASHKO, 1976), Crimea (LIVSHITS *et al.*, 1979), China (DING & YANG, 1983) and Italy (VACANTE & TROPEA GARZIA, 1987b); in the latter country the species has been found on the bark of lemon and orange trees in Sicily and Calabria.

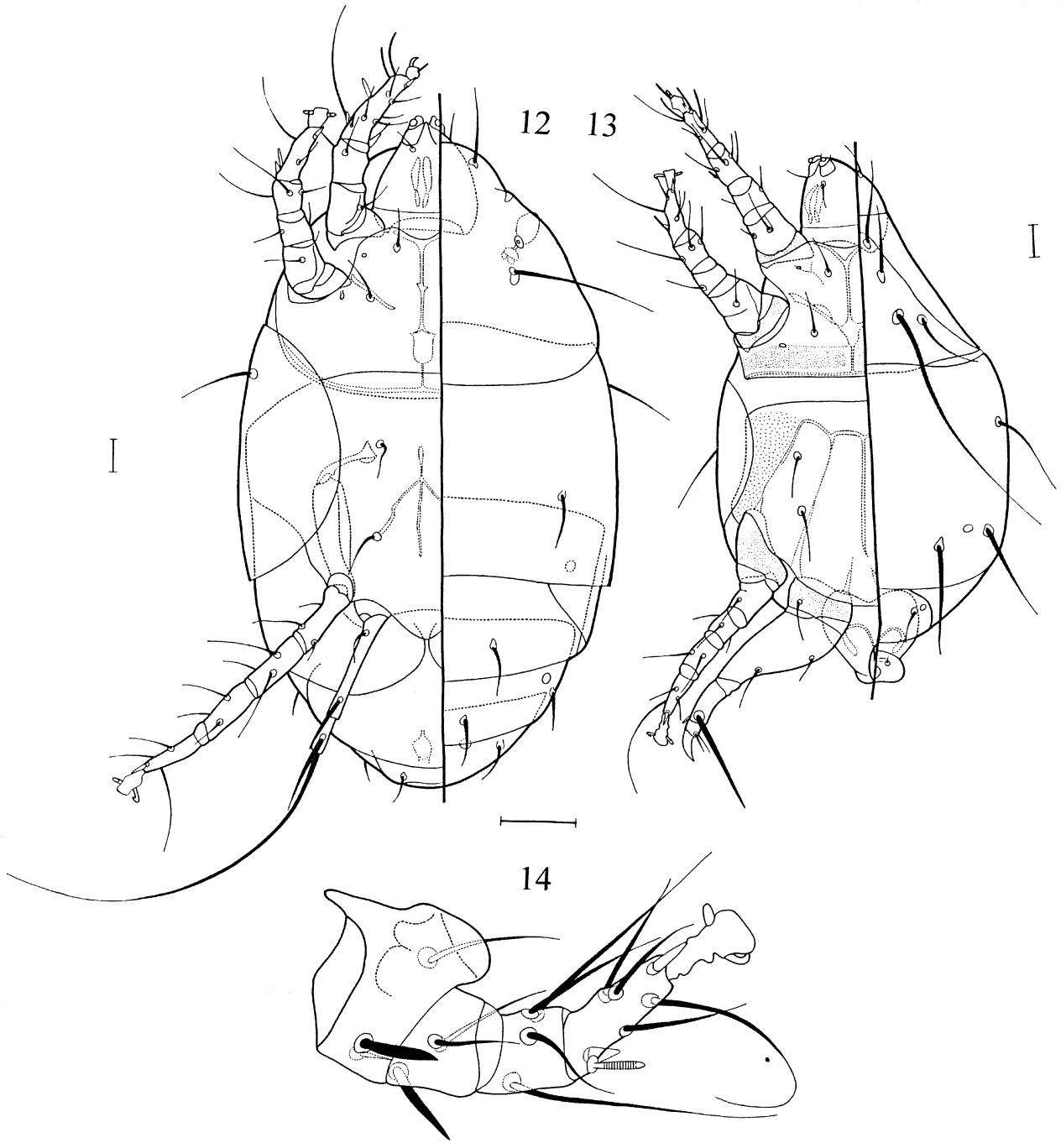
BEER (1954) states that he studied specimens collected on various host plants in laboratory cultures on *Fusarium oxysporum* var. *dianthi* or on *Sporotrichium* sp. SUSKI (1972) reports that, in the laboratory, *T. confusus* does not reproduce on the fungus *Hormodendrum resinae* Linder but can be reared on yeast. LINDQUIST (1986) writes that the species apparently feeds on a wide variety of fungi and that it sometimes creates problems for laboratory cultures of fungi. For example, at the Biosystematics Research Institute of Ottawa he observed that the mite infested species belonging to the genera *Trichoderma*, *Geomyces*, *Cladosporium*, *Hormiactis*, *Stachybotris*, *Botryosporium*, *Cladobotryum*, *Beauveria* and *Ulocladium*.

Tarsonemus* (*Tarsonemus*) *smithi Ewing

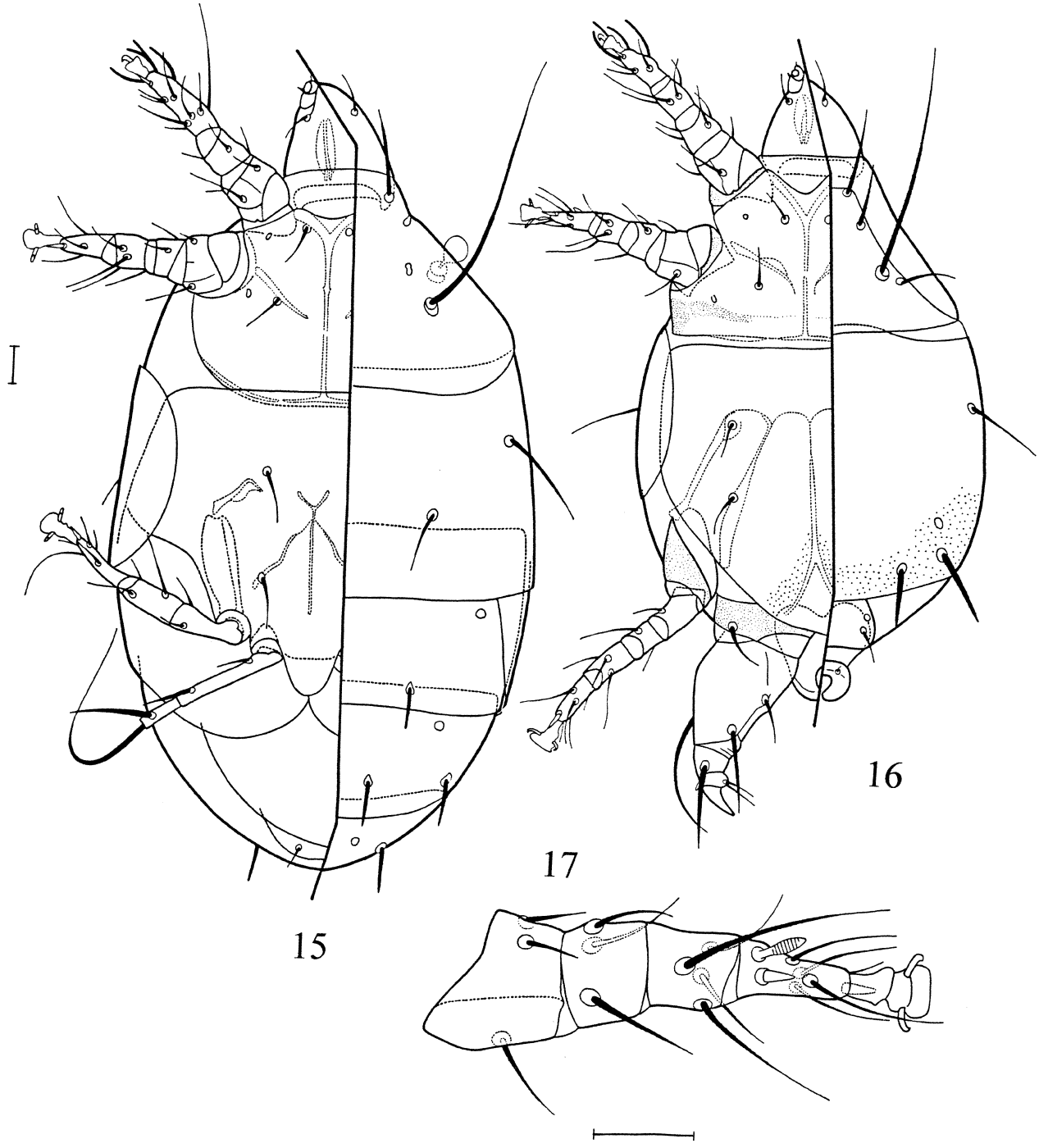
(figs. 12-14)

Tarsonemus smithi Ewing, in EWING H. E., 1939, A revision of the mites of the subfamily Tarsoneminae of North America, the West Indies and the Hawaiian Islands. Tech. Bull. U.S. Dept. agric., 653: 18.

The species is widespread and known in North America (EWING, 1939; BEER, 1954), Japan (ITO,



FIGS. 12-14. — *Tarsonemus smithi* Ewing, dorsal view (on the right) and ventral view (on the left) of female (12) and male (13), leg II of female (14). The scale bars correspond to 10 μm.



FIGS. 15-17. — *Tarsonemus floricolus* Canestrini and Fanzago, dorsal view (on the right) and ventral view (on the left) of female (15) and male (16), leg II of male (17). The scale bars correspond to 10 μm.

1963), Germany (Karl, 1965), Israel (Gerson, 1971), Poland (Suski, 1972), Crimea (Livshits *et al.*, 1979), Taiwan (Tseng & Lo, 1980), Italy (Vacante & Nucifora, 1985), Lybia (Vacante & Di Martino, 1987) and China (Chen & Ma, 1992).

The mite reproduces on *Alternaria tenuis* and *H. resinae*, but the former species is a better food substrate (Suski, 1972). In Italy, the Tarsonemid was found on both vegetables in the greenhouse (Vacante 1989) and *Citrus* (Vacante & Nucifora, 1985; Vacante & Delrio, 1987); there, the mite occurred on leaves, fruit, small branches with sooty mould and in bark crevices of the trunk or large branches.

Tarsonemus* (*Tarsonemus*) *floricolus
Canestrini and Fanzago
(figs. 15-17)

Tarsonemus floricolus Canestrini and Fanzago, in Canestrini G. and Fanzago F., 1876, Nuovi Acari Italiani (Seconda Serie). Atti Soc. Veneto-Trentina Sci. Nat., 5: 141.

Widespread species known in Italy (Canestrini & Fanzago, 1876), Germany (Schaarschmidt, 1959), ex-Czechoslovakia (Daniel, 1971) and Taiwan (Tseng, 1978). The Tarsonemid is frequent on *Citrus* in Sicily and Calabria and can be recovered from leaves, fruit and small branches, most frequently in association with sooty mould.

Laboratory experiments carried out by the authors enabled them to ascertain that the species lives and reproduces on *Alternaria* sp.

Tarsonemus* (*Tarsonemus*) *bilobatus Suski
(figs. 18-20)

Tarsonemus bilobatus Suski, in Suski Z. W., 1965a, Tarsonemid Mites on Apple Trees in Poland. II. *Tarsonemus bilobatus* n. sp. (*Acarina*, *Tarsonemidae*). Bull. Acad. Pol. Sci. Cl. V. ser. Sci. Biol., 13: 539.

Widespread species, known in Poland (Suski, 1965a), Byelorussia (Mitrofanov & Trepashko, 1976), Egypt (Korah & Osman, 1978), Crimea (Livshits *et al.*,1979), Hungary (Nemestothy, 1984), China (Piao, 1990), Costa Rica (Vargas & Ochoa, 1990), Japan (Nakao, 1991), Korea (Na *et al.*, 1998) and Italy, where until now, it was only found on vegetables and ornamentals in greenhouses (Vacante, 1989). During this investigation, the Tarsonemid was found for the first time on *Citrus* where it was sporadically collected on orange fruit and leaves, as well as on clementines and lemons with sooty mould in Sicily, Calabria and Liguria.

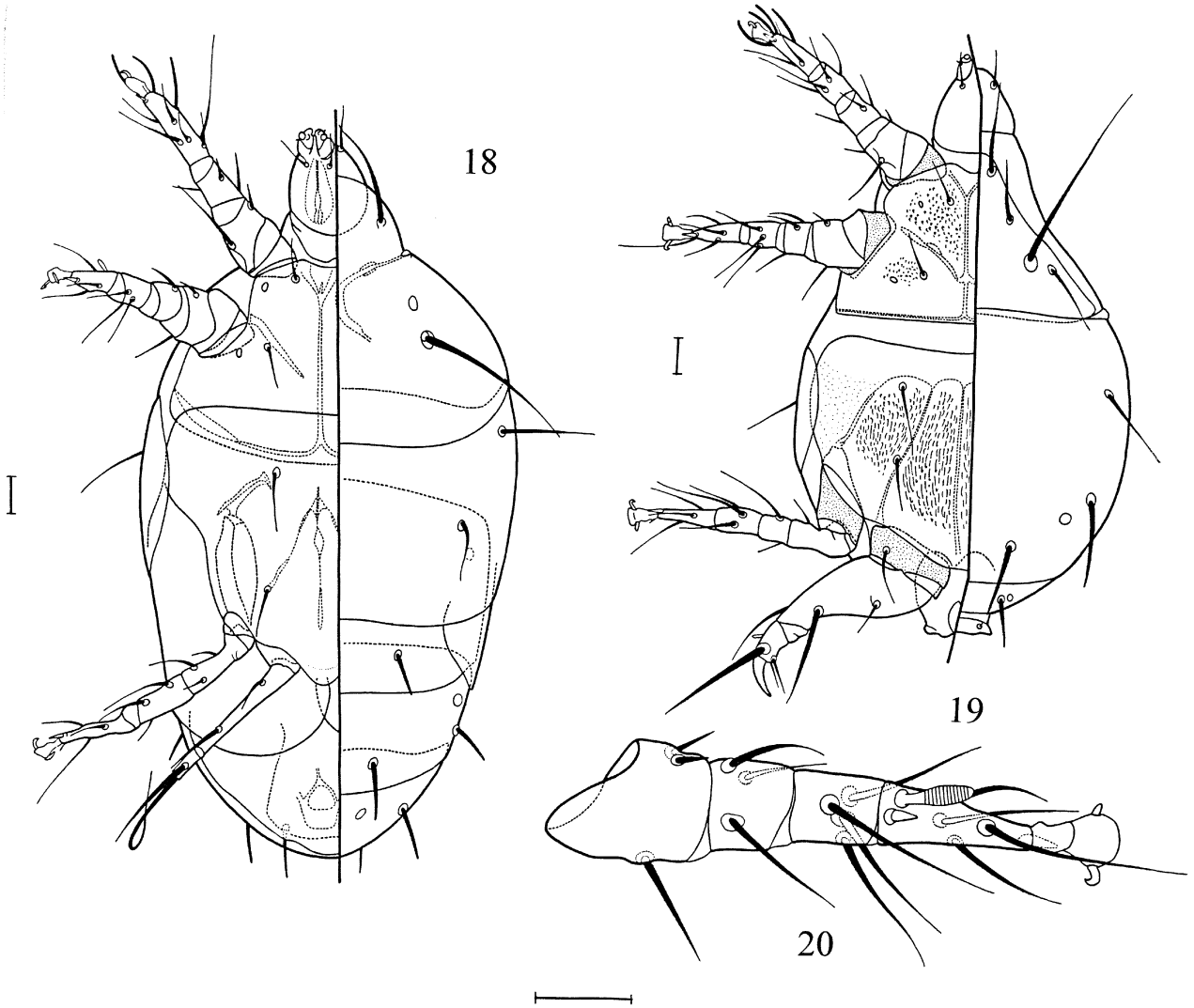
Suski (1972) observed that in the laboratory, the mite does not reproduce on the fungus *H. resinae* but on yeast. Korah & Osman (1978) state that the species damages many plants including fava beans and wheat; Nemestothy (1984) revealed, in Hungary, that among the 20 Tarsonemid species found on garden plants only *T. bilobatus* associated with *T. pallidus* Banks and *P. latus* was responsible for damage to vegetables. The latter cases, however, are not very clear and require, according to Lindquist (1986), further investigation. Vargas & Ochoa (1990) report that the mite is responsible for serious damage to cultures of mushrooms (*Alternaria* spp., *Helminthosporium* sp., *Moniliophthora roreri*, *Phytophthora* spp., *Rhizoctonia* sp e *Trichoderma* sp.) and bacteria (*Erwinia* spp., *Pseudomonas solanacearum*) in the laboratory.

Tarsonemus* (*Tarsonemus*) *idaeus Suski
(figs. 21and 22)

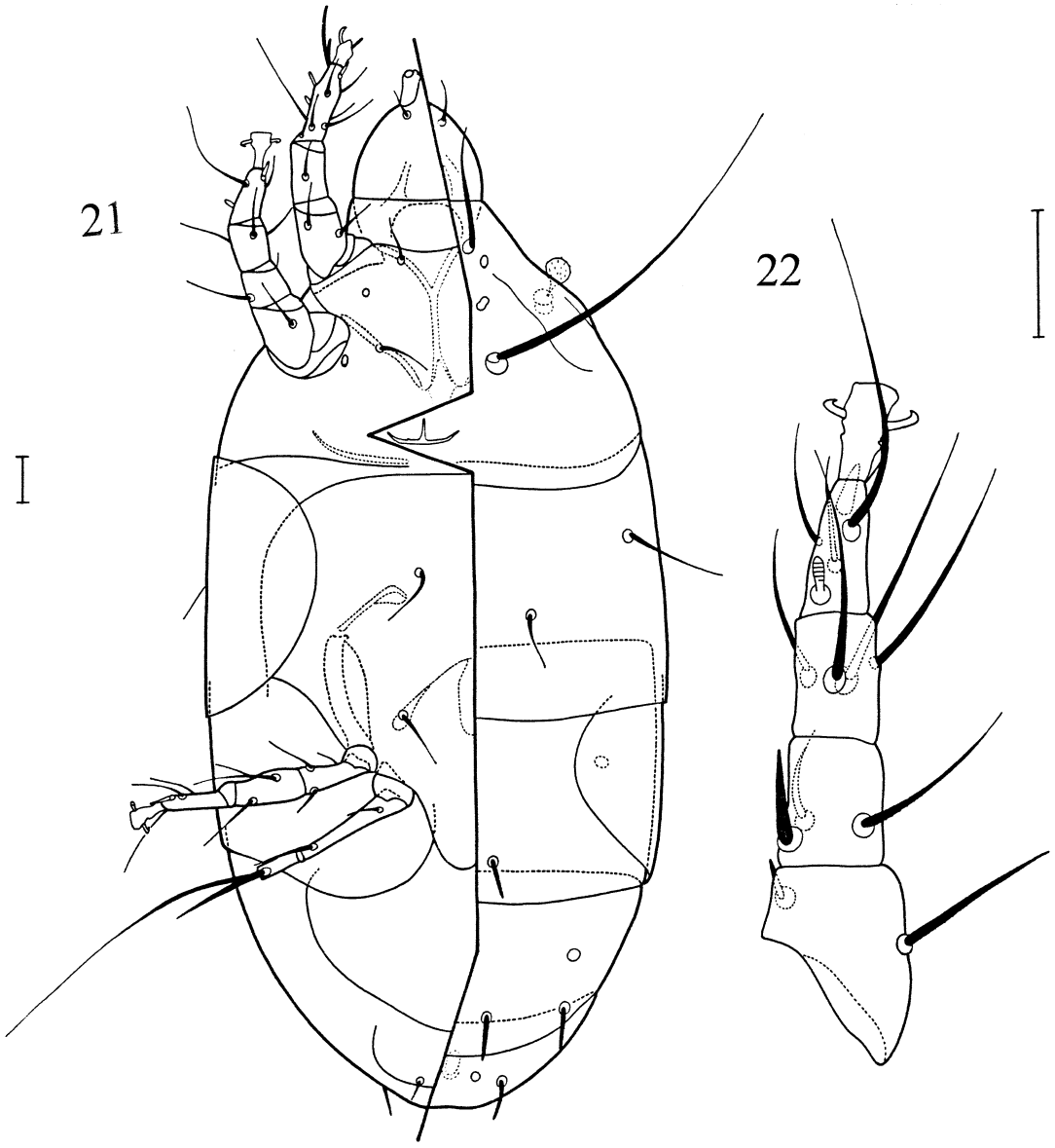
Tarsonemus idaeus Suski, in Suski Z. W., 1968, Polish Mites of the family *Tarsonemidae* (*Acarina*, *Heterostigmata*). *Tarsonemus idaeus* n. sp. Bull. Acad. Pol. Sci. Cl. V. ser. Sci. Biol., 16: 637.

Species known in Poland (Suski, 1968), Egypt (Korah & Osman, 1978), Italy and China (Yin *et al.*, 1998). On *Citrus* in Italy, the mite is not frequent; during this investigation, the species was found in Sicily and Calabria on leaves as well as fruit of orange and lemon trees with sooty mould.

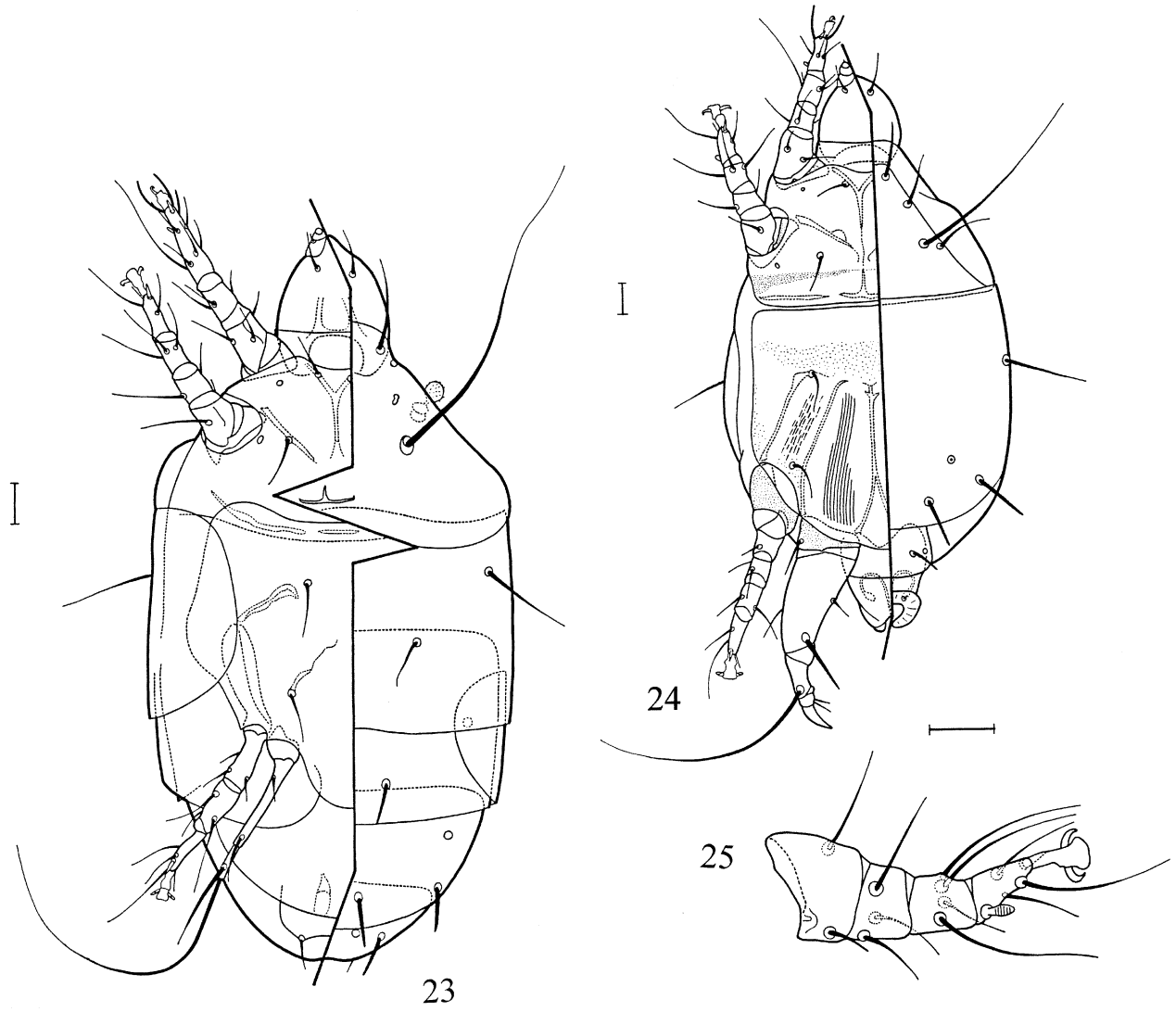
Suski (1968) reports that the Tarsonemid develops either on fungi or on yeast. Also, Korah & Osman (1978) state that it is a fungivorous species.



FIGS. 18-20. — *Tarsonemus bilobatus* Suski, dorsal view (on the right) and ventral view (on the left) of female (18) and male (19), leg II of male (20). The scale bars correspond to 10 μm.



FIGS. 21 and 22. — *Tarsonemus idaeus* Suski, dorsal view (on the right) and ventral view (on the left) of female (21), leg II of female (22). The scale bars correspond to 10 μm.



FIGS. 23-25. — *Tarsonemus waitei* Banks, dorsal view (on the right) and ventral view (on the left) of female (23) and male (24), leg II of male (25). The scale bars correspond to 10 μm.

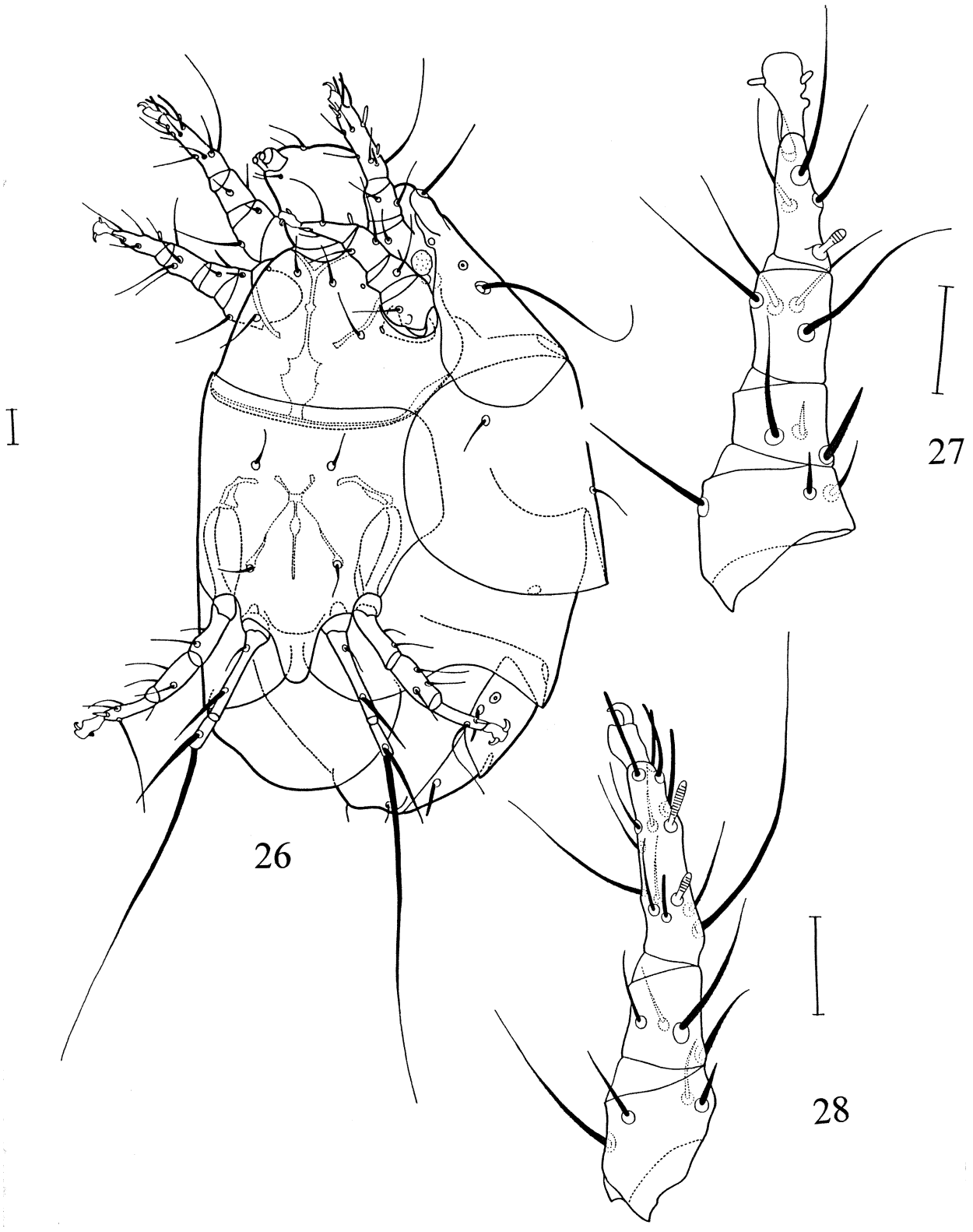
Tarsonemus* (*Tarsonemus*) *waitei Banks

(figs. 23-25)

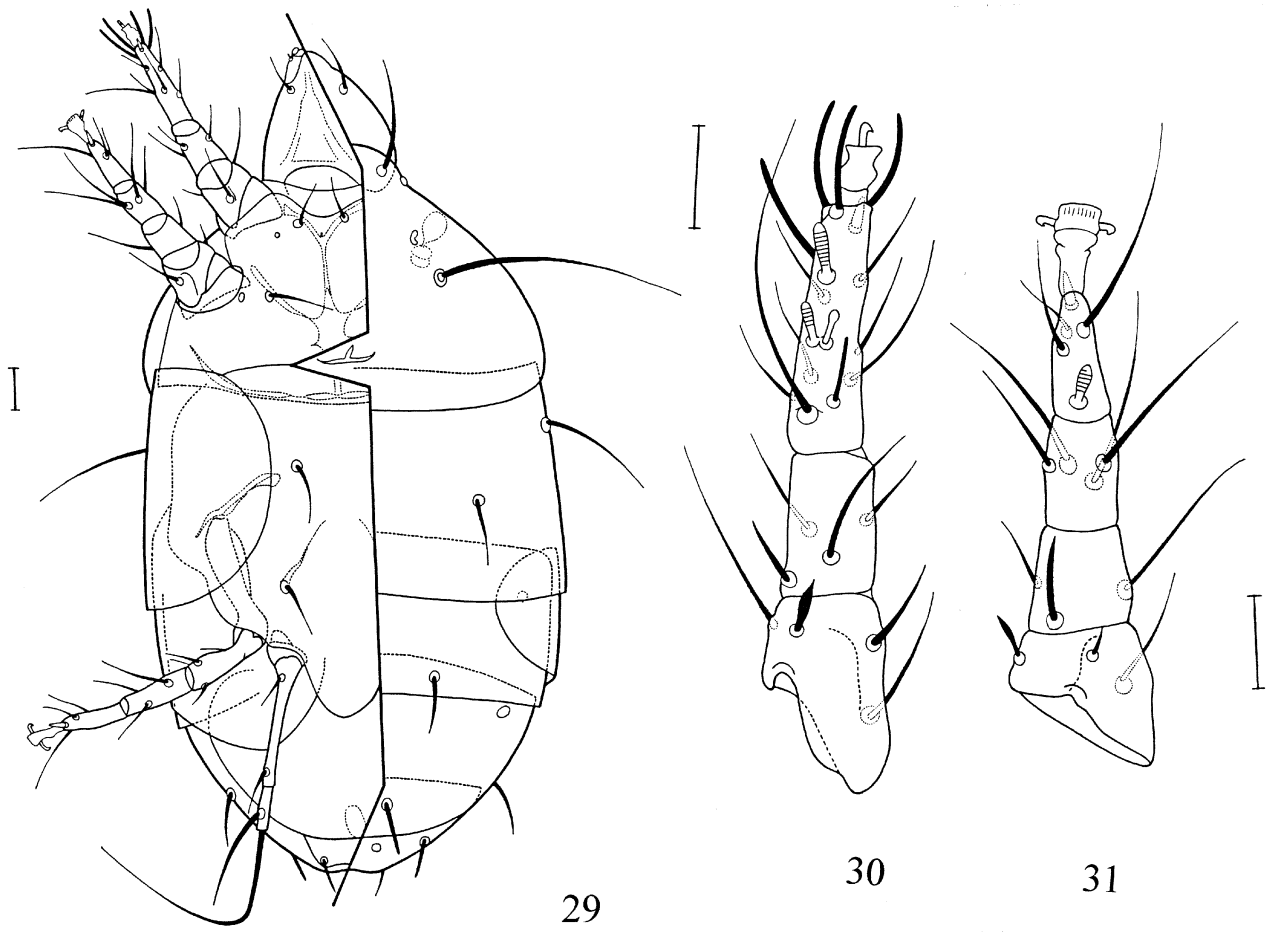
Tarsonemus waitei Banks, in BANKS N., 1912, New American mites. Proc. Entomol. Soc. Wash., 14: 96.

Widespread species, mainly distributed in temperate and subtropical areas (LINDQUIST, 1978), found, in Italy, on various vegetables (VACANTE, 1989), trees (VACANTE & TROPEA GARZIA, 1987a, 1988), and commonly found on *Citrus* (Vacante and Nucifora, 1985). There, the mite is observed on flowers, leaves, small branches and fruits with sooty mould as well as in bark crevices on branches and trunks.

Although the dietary regime is of fungivorous type (BEER, 1954; SUSKI, 1972; LINDQUIST, 1978; NUCIFORA & VACANTE, 1986), a hypothesised trend to phytophagy cannot be ruled out and requires verification (LINDQUIST, 1978).



FIGS. 26-28. — *Tarsonemus lobosus* Suski, ventrolateral view of female (26), leg I (27) and II (28) of female. The scale bars correspond to 10 μm.



FIGS. 29-31. — *Tarsonemus parawaitei* Kim *et al*., dorsal view (on the right) and ventral view (on the left) of female (29), leg I (30) and II (31) of female. The scale bars correspond to 10 μm.

Tarsonemus* (*Tarsonemus*) *lobosus Suski

(figs. 26-28)

Tarsonemus lobosus Suski, in SUSKI Z. W., 1965b, Tarsonemid Mites on Apple Trees in Poland. III. *Tarsonemus lobosus* n. sp. (*Acarina*, *Tarsonemidae*). Bull. Acad. Pol. Sci. Cl. V. ser. Sci. Biol., 13: 587.

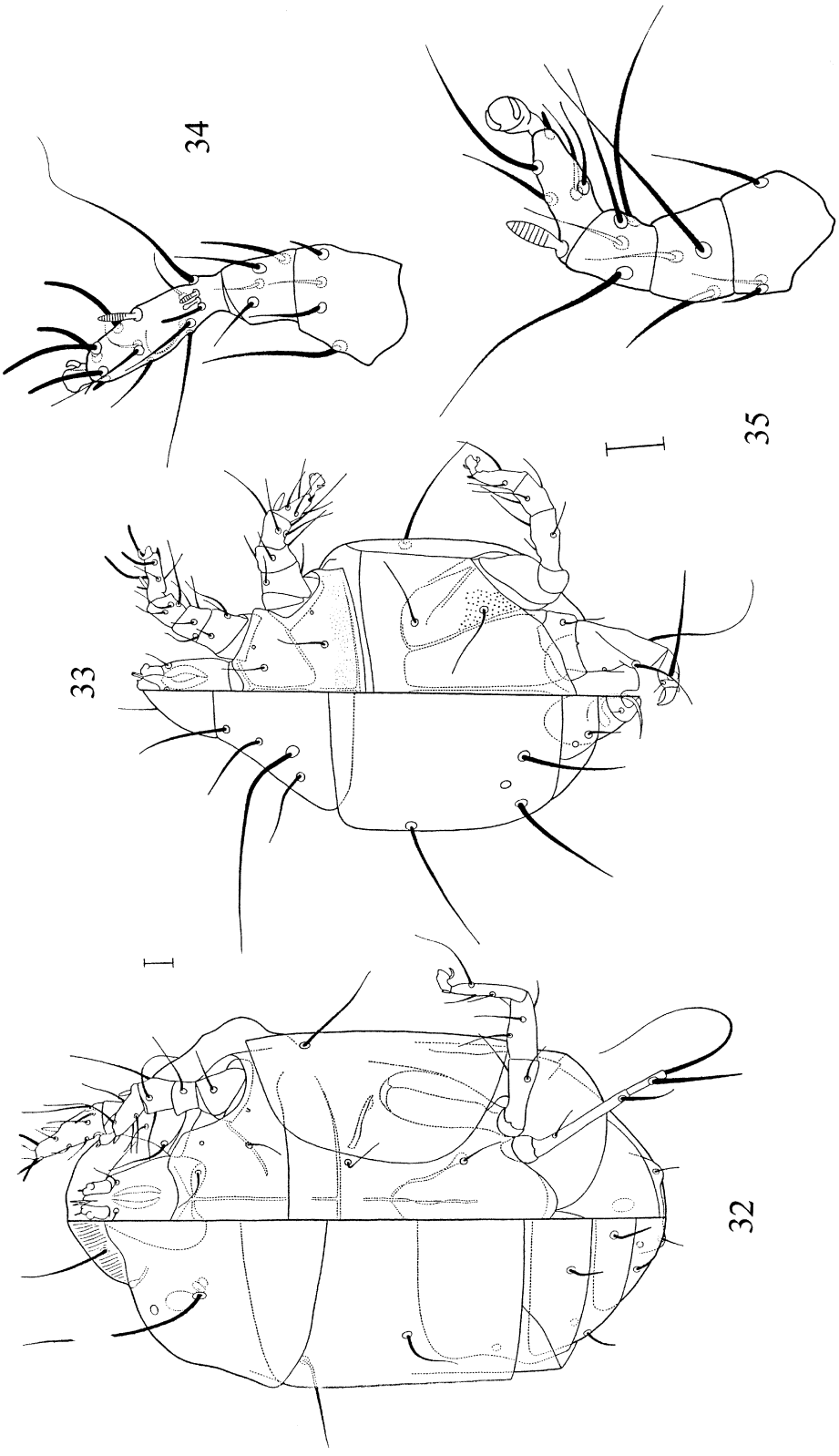
The species is known in Poland (SUSKI, 1965b), Crimea (LIVSHITS *et al.*, 1979) and Italy. During this investigation in Sicily, the species was occasionally collected in bark crevices of the trunk and large branches of orange and lemon trees.

The dietary regime seems to be fundamentally of fungivorous type (SUSKI, 1972).

Tarsonemus* (*Tarsonemus*) *parawaitei
Kim, Qin and Lindquist

(figs. 29-31)

Tarsonemus parawaitei Kim, Qin and Lindquist, in KIM J. S., QIN T. K. & LINDQUIST E. E., 1998, Descripition of *Tarsonemus parawaitei*, a new species of Tarsonemidae (Acari: Heterostigmata) associated with orchard and ornamental plants in Europe, Australia and New Zeland. Syst. Appl. Acarol. Spec. Publ. (1998) 2: 1.



FIGS. 32-35. — *Tarsonemus aurantii* Oudemans, dorsal view (on the left) and ventral view (on the right) of female (32) and male (33), leg I of female (34), leg II of male (35). The scale bars correspond to 10 μm.

Species with wide geographic distribution and known in Germany, Italy, France, and New Zealand (Kim *et al*., 1998). In Italy, the mite has been collected on *Citrus* and, for the time being and in absence of a definitive description and according Lindquist (1978) it is referred to as *T. setifer* Ewing (*sensu* Karl, 1965) (Vacante & Tropea Garzia, 1987; Vacante & Delrio, 1987). The Tarsonemid is common in Italy on many plants including *Citrus* where it inhabits all epigeic organs and occurs, often associated with sooty mould, in the bark crevices of trunks and large branches.

With regard to dietary regime, in all likelihood the species is fundamentally fungivorous. Nevertheless, a secondary adaptation to phytophagy, as postulated for *T. watei* cannot be ruled out and may be responsible for hypothetical leaf distorsions that merit further studies (Lindquist, 1978; Kim *et al*., 1998)

Tarsonemus* (*Tarsonemus*) *aurantii Oudemans

(figs 32-35)

Tarsonemus aurantii Oudemans, in Oudemans A.C., 1927, Over de door hem onderzochte Acari. Tijdschr. Ent., 70: 34.

The species has recently been re-described by Vacante (in press) and is known in the mediterranean region in general and Israel (Gerson, 1971) as well as Italy in particular (Vacante & Nucifora, 1985; Vacante & Tropea Garzia, 1987). In Sicily and Calabria the Tarsonemid is commonly found, often associated with sooty mould, on the leaves and fruit of various *Citrus* species.

Laboratory experiments carried out by the authors indicate that *T. aurantii* reproduces on *Alternaria* sp.

Conclusions

The investigation provided evidence of the existence of a modest number of species. From an ecological standpoint, only *P. latus* is clearly injurious, while the remaining species are fungiphagous or phytophagous on epiphytic algae and lichens on trees and, occasionally, may be able to transport fungal pathogens or may serve as alternative prey for a number of Phytoseiids (Suski, 1972; Lindquist, 1986). Regarding the hypothetically injurious species such as *T. waitei* and *T. parawaitei*, further research is necessary. As a result, we may be able to hypothesize that part of the damage to *Citrus* fruits commonly attributed to the feeding activities of Thrips and/or other phytophagous species can be attributed to the feeding activities of Tarsonemids.

REFERENCES

Banks (N.), 1904. — Class III, Arachnida, Order I, Acarina, four new species of injurious mites. — J. N. Y. Entomol. Soc., 12: 53-56.

Banks (N.), 1912. — New American mites. — Proc. Entomol. Soc. Wash., 14, 2: 96-99.

Beer (R. E.), 1954. — A Revision of the Tarsonemidae of the Western Hemisphere (Order Acarina). — Univ. Kansas Sci. Bull., 36, II: 1091-1387.

Canestrini (G.) & Fanzago (F.), 1876. — Nuovi Acari Italiani, serie II. — Atti Soc. Veneto-Trentina Sci. Nat., 5: 130-142.

Chen (X. B.) & Ma (E. P.), 1992. — Researches of Acarology in China. — Chongqing Press, Chongqing, 170 pp.

Daniel (M.), 1971. — Podrad Sametkovci-Trombidiformes, Nadkohorta Roztoci-Tarsonemini, Nadkohorta Sametky-Prostigmata, pp 357-422, in M. Daniel, and V. Cerny (eds), Kliczvireny CSSR, vol. 4 (in Czech.).

De Leon D., 1956. Some Mites from Lychee. Fla Entomol., 39: 163-173.

Ding (T. Z.) & (Q. S.) Yang, 1983. — Diagnosis of tarsonemid species in rice. — Plant Prot., 9, 6: 17-18.

Ewing (H. E.), 1939. — A revision of the mites of the subfamily Tarsoneminae of North America, the West Indies, and the Hawaiian Islands. — Tech. Bull. U.S. Dept. agric., 653: 1-64.

Gerson (U.), 1971. — The mites associated with Citrus in Israel. — Israel J. Entomol., 6: 5-22.

Ito (Y.), 1963. — Six Newly Recorded Species of Tarsonemid-mites in Japan. — Jpn. J. Appl. Entomol. Z., 7, 1: 14-19.

Lindquist (E. E.), 1978. — On the synonymy of *Tarsonemus waitei* Banks, *T. setifer* Ewing, and *T. bakeri* Ewing, with redescription of species (Acari: Tarsonemidae). — Can. Entomol., 110: 1023-1048.

Lindquist (E. E.), 1986. — The world genera of Tarsonemidae (Acari: Heterostigmata): A morphological, phylogenetic, and systematic revision, with a reclassification of

family-group taxa in the Heterostigmata. — Mem. Entomol. Soc. Can., 136: 1-517.

Livshits (I.Z.), Mitrofanov (V. I.) & Sharonov (A.A.), 1979. — Raznokogotkovye kleschi fauny Kryma (Tarsonemidae: Acariformes), in I.Z. Livshits, (ed.), Vrediteli i bolezni lesoparkovych i plodovych nasazhdenii Kryma. — Trudy Gosudarstvennogo Nikitskogo Botanikeskogo Sada, Yalta, 79: 7-50.

Lombardini (G.), 1959. — Acari Nuovi. XXXVII. — Boll. Ist. Ent. agr. Oss. Fitopat. Palermo, 3: 163-168.

Jeppson (L. R.), Keifer (H. H.) & Baker (E. W.), 1975. — Mites Injurious to Economic plants. — University of California Press, Berkeley, Los Angeles, London, 614 pp.

Karl (E.), 1965. — Untersuchungen zur Morphologie und Ökologie von Tarsonemiden gärtnerischer Kulturpflanzen. — Biol. Zbl., 84: 331-357.

Kim (J. S.), Qin (T. K.) & Lindquist (E.E.), 1998. — Description of *Tarsonemus parawaitei*, a new species of Tarsonemidae (Acari: Heterostigmata) associated with orchard and ornamental plants in Europe, Australia and New Zealand. — Syst. Appl. Acarol. Spec. Publ., 2: 1-28.

Korah (S. M. Abo) & Osman (A. A.), 1978. The tarsonemid mites under certain field crops in Menoufia Governorate, Egypt. — Bull. Soc. Entomol. Egypte, 62: 191-196 (in English).

Mitrofanov (V. I.) & Trepashko (L. I.), 1976. — Kleshchi, vyzyvayushchie belokolosost' zlakov v Belorussii. — Zool. Zh., 55: 771-773 (in Russian).

Na (S. Y.), Cho (M. R.), Kim (D. S.), Park (K. W.), Woo (C. K.) & Kim (K. T.), 1998. — Survey on the pests of stored garlic. — Korean J. Appl. Entomol., 37, 1: 65-71 (in Korean).

Nakao (H.), 1991. — Studies on acarid mites (Acari: Astigmata) damaging vegetable plants. II. Damage to vegetable seedlings. — Jpn. J. Appl. Entomol. Z., 35, 4: 303-309 (in Japanese).

Nemestothy (K. K.), 1984. Tarsonemiden Milben der gartnerischen Kulturpflanzen Ungarns. — Folia ent. hung., 45: 45-47.

Nucifora (A.), 1961. Un nuovo acaro dannoso ai limoni in Sicilia (*Hemitarsonemus latus* Banks). — Tec. agric. Catania, 2: 3-11.

Nucifora (A.), 1980. — Infestazioni di *Polyphagotarsonemus latus* (Banks) su colture di gerbera e di peperone in serra e su piante ortive e floreali di pieno campo. — Atti Giornate Fitopatologiche, 1: 359-365.

Nucifora (A.) & Vacante (V.), 1986. — Laboratory observations on the biology of *Tarsonemus waitei* Banks. — Proceedings Experts' Meeting "Integrated pest control in citrus-groves", Acireale, 26-29 March 1985, Balkema (ed.), Rotterdam, Boston: 203-207.

Nucifora (A.) & Vacante (V.), 2002. — Gli acari degli agrumi in Italia. IV. Famiglia Tarsonemidae. Lista delle specie rinvenute e chiave per la loro identificazione. — Atti XIX Congr. naz. ital. Entomol., Catania, 10-15 giugno 2002 (in press).

Oudemans (A.C.), 1927. — Over de door hem onderzochte Acari. — Tijdschr. Ent., 70: 34-35.

Piao (X. G.), 1990. — Studies on the mites infesting herb medicine in China and Japan and their derivation. — Jpn. J. Sanit. Zool., 41, 1: 1-7.

Schaarschmidt (L.), 1959. — Systematik und Okologie der Tarsonemiden. — Beitr. Sys. Ökol. Mitteleur. Acarina I. Abschn., 5: 713-823.

Suski (Z. W.) 1965a. — Tarsonemid Mites on Apple Trees in Poland. II. *Tarsonemus bilobatus* n.sp. (*Acarina Tarsonemidae*). — Bull. Acad. Pol. Sci. Cl. V, XIII, 9, Sci. Biol.: 539-544.

Suski (Z. W.), 1965b. — Tarsonemid Mites on Apple Trees in Poland. III. *Tarsonemus lobosus* n.sp. (*Acarina*, *Tarsonemidae*). — Bull. Acad. Pol. Sci. Cl. V, XIII, 10, Sci. Biol.: 587-593.

Suski (Z. W.), 1967a. — Tarsonemid Mites on Apple Trees in Poland. VIII. *Daidalotarsonemus vandevriei* n. sp. (*Acarina*, *Tarsonemidae*). — Bull. Acad. Pol. Sci. Cl. V. ser. Sci. Biol., 15: 227-233.

Suski (Z. W.), 1967b. — Badania nad roztoczami z rodziny Tarsonemidae (Acarina, Heterostigmata) wystepujacymi na jabloniach w Polsce. — Instytut Sadownictwa, Skierniewice: 228 pp. (in Polish).

Suski (Z. W.), 1968. — Polish Mites of the Family *Tarsonemidae* (*Acarina*, *Heterostigmata*). *Tarsonemus idaeus* n.sp. — Bull. Acad. Pol. Sci. Cl. V, XVI, 10, Sci. Biol.: 637-642.

Suski (Z. W.), 1972. — Tarsonemid mites on apple trees in Poland X. Laboratory studies on the biology of certain mite species of the family *Tarsonemidae* (*Acarina*, *Heterostigmata*) in apple orchards. — Zesz. Probl. Post. Nauk Roln., 129: 111-137.

Tseng (Y. H.), 1978. — Phytophagous and predatory mite species in Taiwan and their economic importance. — Academia Sinica Institute of Zoology Monograph Series, 3: 217-254.

Tseng (Y. H.) & Lo (K. C.), 1980. — Tarsonemid mites (Acarina:Prostigmata) from Taiwan. — Plant Prot. Bull., 22: 113-140.

Vacante (V.) & Delrio (G.), 1987. — Gli acari degli agrumi in Sardegna. — Il recente contributo della ricerca allo sviluppo dell'agrumicoltura italiana, Cagliari 29 aprile-3 maggio 1986, Delfino (ed.), Roma: 565-572.

Vacante (V.) & Di Martino (E.), 1987. — Reperti sull'acarofauna degli agrumi in Libia. 1985. — Il recente contributo della ricerca allo sviluppo dell'agrumicoltura

italiana, Cagliari 29 aprile-3 maggio 1986, Delfino (ed.), Roma: 559-563.

Vacante (V.) & Nucifora (A.), 1985. Gli Acari degli agrumi in Italia. I. Specie rinvenute e chiave per il riconoscimento degli ordini, dei sottordini e delle famiglie. — Boll. Zool. agr. Bachic., ser.II, 18: 115-166.

Vacante (V.) & Tropea Garzia (G.), 1987a. — Grape mites in Sicily- Contribution I. — Integrated pest control in viticulture, Proceedings of a meeting of the EC Experts' Group, Portoferraio, 26-28 september 1985, Balkema (ed.), Rotterdam, Brookfield: 207-215.

Vacante (V.) & Tropea Garzia (G.), 1987b. — Gli acari corticicoli degli agrumi in Sicilia. — Il recente contributo della ricerca allo sviluppo dell'agrumicoltura italiana, Cagliari 29 aprile-3 maggio 1986, Delfino (ed.), Roma: 573-578.

Vacante (V.) and Tropea Garzia (G.), 1988. — Reperti dell'acarofauna del melo in Sicilia. — La coltura del melo verso gli anni 90, Chiandetti (ed.), Reana del Rojale, Udine: 609-616.

Vacante (V.), 1989. — Les acariens des cultures protégées de la region Méditerranéenne. — Integrated control in protected vegetable crops, Lectures delivered during a CEC-IOBC training course, Commission of the European Communities, Luxembourg: 137-152.

Vacante (V.), 2002. — Gli acari degli agrumi in Italia. V. Famiglia Tarsonemidae. Ridescrizione di *Tarsonemus* (*T.*) *aurantii*. — Atti XIX Congr. naz. ital. Entomol., Catania, 10-15 giugno 2002 (in press).

Vacante (V.), 2002. — Gli acari degli agrumi in Italia. VI. Famiglia Tarsonemidae. Ridescrizione di *Fungitasonemus monasterii*. — Atti XIX Congr. naz. ital. Entomol., Catania, 10-15 giugno 2002 (in press).

Vargas (C.) & Ochoa (R.), 1990. — Medios de cultivo en laboratorio contaminados por *Tarsonemus bilobatus* Suski (Acari; Tarsonemidae) y redescripcion de la espece. — Man. Integ. de Plagas, 18: 19-23 (in Spanish).

Yin (S.G.), Bei (N.X.), Liu (L.), Yu (H.X.), Shi (J.M.) & Tong (Y), 1998. — Two new species and seven new records of Tarsonemidae in China (Acari: Tarsonemidae). — J. Shenyang Agric. Univ., 29, 1: 21-23.