Tyrophagus neiswanderi,
A New Acarid Mite of Agricultural Importance

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Tyrophagus neiswanderi, A New Acarid Mite of Agricultural Importance$^{1,2}$ (Acari-Acaridei)

DONALD E. JOHNSTON and WILLIAM A. BRUCE

Mites of the genus Tyrophagus are the most ubiquitous of Acari. They may be encountered in stored food products, farmyards, mosses, litter, humus and soil, higher fungi, roots of plants, and nests of mammals, birds and social insects. The group is virtually cosmopolitan in distribution.

One of the most unusual situations in which Tyrophagus has been found is on the aerial parts of higher plants where the mites were actually feeding on the tissues of the plant. This phenomenon was first brought to the authors' attention by Dr. R. B. Neiswander, who observed Tyrophagus feeding on foliage of greenhouse cucumbers in northern Ohio. In three of the four instances observed by Dr. Neiswander, a new species of Tyrophagus was involved.

This bulletin describes this species and summarizes the current taxonomy of the genus Tyrophagus, with special emphasis on forms of agricultural interest.

**TYROPHAGUS NEISWANDERI NEW SPECIES$^3$**

**Male** (holotype). Idiosoma 413 microns in length (from level of internal vertical setae to posterior margin of notogaster). Idiosomal chaetotaxy normal. Measurements of dorsal setae as follows (in microns): $d_1$ 43; $d_2$ 63; $la$ 40; $d_2/la$ 1.58.

Supracoxal seta $elc$ I (pseudostigmatic hair of authors) narrowly lanceolate, setulose, distally attenuate (putrescentiae type) (Fig. 1B).

Aedeagal supporting sclerites curved laterad (Fig. 1A). Aedeagus relatively small, with one major curve, distal end straight or nearly so (described from paratypes, Fig. 3D). Distance between basal element of genitalia and anal groove much less (13 microns) than length of anal groove (65 microns).

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$^3$Based on work supported in part by National Science Foundation Grant G-19325.

$^3$The authors take pleasure in naming this mite for its discoverer, Dr. Ralph B. Neiswander, Professor Emeritus of Zoology and Entomology, Ohio Agricultural Research and Development Center.
Tarsus I 68 microns in length. \(\omega_1\) long; not enlarged at tip. Famulus (\(\eta\)) short, stout (Figs. 1C, 4A). \(\beta, \alpha, \text{and } \omega_1\), not in line. Tarsus IV (Fig. 1D): \(\alpha + \beta\) 48 microns; \(c\) 30 microns; \(\alpha + \beta/c\) 1.6. Combined length of genu and tibia IV subequal to length of tarsus IV. Chaetotaxy of legs normal.

Chelicerae and subcapitulum normal. Supracoxal seta (\(\epsilon\rho\)); maxillary seta of Zakhvatkin) short, broad, smooth (\(\text{putrescentiae}\) type).

**Holotype** ex laboratory culture originating from specimens found feeding on cucumber plants in a commercial greenhouse, Olmstead Falls, Ohio, on May 1, 1964; R. B. Neiswander, collector (sample No. 583); deposited in U. S. National Museum.

Other males studied were from sample No. 583 and from another collection as follows:

Numerous specimens feeding on cucumber plants and in peanut hull litter surrounding plants, Botany greenhouse, Ohio Agricultural Research and Development Center, Wooster, Ohio, on April 1, 1963; D. E. Johnston and J. H. Gregory collectors (sample Nos. 433, 434).

Variation in males. Given below are statistics derived from measurements of several attributes of males from the type series. These are arranged as follows — attribute: mean ± standard error; coefficient of variability; range; number of observations.

**Sample 583**

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Mean ± SE</th>
<th>Coefficient of Variability</th>
<th>Range</th>
<th>Number of Observations</th>
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<tbody>
<tr>
<td>(d_1)</td>
<td>31.6 ± .81</td>
<td>12.0; 25-40; 22</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(d_2)</td>
<td>47.1 ± .83</td>
<td>7.6; 38-52; 19</td>
<td></td>
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<tr>
<td>(l_a)</td>
<td>33.4 ± .60</td>
<td>10.5; 29-43; 34</td>
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<td></td>
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<tr>
<td>(d_2/l_a)</td>
<td>1.44 ± .03</td>
<td>8.5; 1.2-1.7; 18</td>
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<tr>
<td>(\alpha + \beta)</td>
<td>42.8 ± .73</td>
<td>8.2; 35-52; 23</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(c)</td>
<td>23.0 ± .57</td>
<td>11.9; 18-27; 23</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(\alpha + \beta/c)</td>
<td>18.6 ± .51</td>
<td>13.1; 1.5-2.6; 23</td>
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**Samples 433, 434**

<table>
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<tr>
<th>Attribute</th>
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<th>Coefficient of Variability</th>
<th>Range</th>
<th>Number of Observations</th>
</tr>
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<tbody>
<tr>
<td>(d_1)</td>
<td>40.1 ± .81</td>
<td>12.6; 29-48; 39</td>
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<tr>
<td>(d_2)</td>
<td>65.7 ± 2.1</td>
<td>15.1; 48-81; 22</td>
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<tr>
<td>(l_a)</td>
<td>42.3 ± .91</td>
<td>14.5; 28-51; 46</td>
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<tr>
<td>(d_2/l_a)</td>
<td>1.58 ± .04</td>
<td>10.9; 1.4-2.0; 16</td>
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<tr>
<td>(\alpha + \beta)</td>
<td>51.0 ± .50</td>
<td>6.4; 43-63; 43</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(c)</td>
<td>27.4 ± .57</td>
<td>13.6; 13-35; 43</td>
<td></td>
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<tr>
<td>(\alpha + \beta/c)</td>
<td>19.2 ± .80</td>
<td>27.3; 1.5-4.8; 43*</td>
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</tbody>
</table>

*Some of the statistics for \(\alpha + \beta, c, \text{and } \alpha + \beta/c\) for this sample are greatly affected by the inclusion of one otherwise 'normal' male with the following measurements: \(\alpha + \beta\) 63, \(c\) 13, \(\alpha + \beta/c\) 4.85. The ranges of \(\alpha + \beta, c, \text{and } \alpha + \beta/c\) for the other 42 specimens are 43-58, 20-35, and 1.5-2.4, respectively.*
Female illustrated in Fig. 2. Measurements of dorsal setae of females from two samples are as follows:

Sample 583
\[
\begin{align*}
&d_1: \quad 41.3 \pm 1.8; \quad 16.6; \quad 33-63; \quad 15 \\
&d_2: \quad 64.6 \pm 1.7; \quad 10.4; \quad 51-76; \quad 15 \\
&la: \quad 38.6 \pm 1.2; \quad 12.2; \quad 33-48; \quad 15 \\
&d_2/la: \quad 1.72 \pm .06; \quad 10.8; \quad 1.5-2.1; \quad 11
\end{align*}
\]

Samples 433, 434
\[
\begin{align*}
&d_1: \quad 51.0 \pm .66; \quad 11.5; \quad 35-63; \quad 79 \\
&d_2: \quad 85.7 \pm 1.8; \quad 11.2; \quad 73-119; \quad 27 \\
&la: \quad 51.1 \pm 5.6; \quad 9.7; \quad 40-68; \quad 80 \\
&d_2/la: \quad 1.71 \pm .12; \quad 31.3; \quad 1.5-2.2; \quad 21
\end{align*}
\]

Egg. Ornamentation of chorion of the longior type; patterns of T. neiswanderi and T. putrescentiae illustrated in Figs. 4E and 4F.

Tyrophagus neiswanderi differs from previously described species of the genus in the combination of states of the following characters: relative lengths of dorsal setae \(d_1, d_2, \) and \(la\); form of the aedeagus; form of the aedeagal supporting sclerites; relative position of the tarsal discs in the male; form and length of omega; form of the supracoxal seta \((elc I)\); and the ornamentation of the chorion.

In the keys of Robertson (4) and Samsinak (6), T. neiswanderi runs to T. javensis. Samsinak has figured the neotype of this species. T. neiswanderi differs from those figures in the shape of the aedeagus and omega. Of the common species of Tyrophagus (longior, mixtus, palmarum, perniciosus, putrescentiae, and similis) likely to be encountered by applied acarologists and entomologists, T. putrescentiae and T. palmarum seem to be those most easily confused with T. neiswanderi. From T. putrescentiae, the new species differs in the shape of the aedeagus and supracoxal seta, dorsal setal pattern, and ornamentation of the chorion (compare Figs. 3B, 3D; 3G, 3I; 4A, 4B). From T. palmarum, it differs in the form of the aedeagal supporting sclerites (curved mediad in palmarum and laterad in neiswanderi).

Material examined. In addition to the collections cited above (samples 433, 434, and 583), the following material of T. neiswanderi has been seen:

Several adults feeding on cucumber plant in greenhouse near Cleveland, Ohio, February 1958 (reported by Neiswander (3) as Tyrophagus sp.).

Several adults and immatures on Carnation culture fungus, Farmingdale, New York, February 17, 1956; G. V. Johnson collector.
Observations on the biology of *Tyrophagus neiswanderi*. The mites from samples 433 and 434 are described here. Similar observations were made on the samples of 1958 and 1964.

The infestation observed in the Botany greenhouse at the Ohio Agricultural Research and Development Center originated from peanut hull litter with which the mites were apparently introduced. The litter had been in place for about 1 month. The mites were extremely abundant and were seen crawling from the litter up the stems of the plants. The greatest number of mites was on the young leaves; others were generally distributed over the plant. Only adults and eggs were seen on the plants. Numerous small holes (up to 4 mm in diameter) were seen in the leaves where feeding by *T. neiswanderi* had occurred. There is no question that this mite was responsible for the feeding damage. Feeding on detached leaves was easily observed with a dissecting microscope and the course of the ingested food within the bodies of these translucent mites could be readily followed.

In the laboratory, *T. neiswanderi* was cultured on a plaster of Paris-charcoal substrate with wetted, activated yeast as food. These cultures were never as successful as similar ones of *T. putrescentiae*. Experiments to determine proper conditions for *T. neiswanderi* were not undertaken. In one instance, an invasion from a neighboring culture of *T. putrescentiae* quickly wiped out *T. neiswanderi*.

**TAXONOMY OF THE GENUS *TYROPHAGUS***

*Tyrophagus* is a difficult genus. This difficulty lies in the homogeneity of exoskeletal anatomy within the genus and in the lack of heteromorphic deutonymphs, or hypopi, which in other genera provide so many useful characters. As larger samples become available, however, it should be possible to characterize at least some kinds of *Tyrophagus* with a fair degree of precision. This precision in identification will permit more sophisticated studies of species of interest. The remainder of this paper summarizes current knowledge of the taxonomy of the genus *Tyrophagus*.

Following is a list of the currently recognized species of *Tyrophagus* based on the recent reviews of Robertson (4) and Samsinak (6). Also listed are synonyms of the valid species and various misidentifications found in the comprehensive works of Zakhvatkin (11), Turk and Turk (8), and Hughes (1). References to these misidentifications are included to facilitate the use of these major works.
SPECIES OF TYROPHAGUS OUDEMANS

1. *brevicrinatus* Robertson, 1959
2. *formicetorum* Volgin, 1948
   Tyrophagus *vjatscheslavi* Sorokin, 1952
4. *longior* (Gervais, 1844)
   Tyroglyphus *infestans* Berlese, 1884
   Tyroglyphus *dimidiatus* forma *humerosus* Oudemans, 1924
   Tyrophagus *tenuiclavus* Zakhvatkin, 1941
5. *miripes* Athias-Henriot, 1961
6. *mixtus* Volgin, 1948
7. *molitor* Zakhvatkin, 1941
8. *neiswanderi* n. sp.
9. *palmarum* (Oudemans, 1924)
   Tyrophagus *viviparus* Oudemans, 1926
   Tyrophagus *parvulus* Volgin, 1949
10. *perniciosus* Zakhvatkin, 1941
11. *putrescentiae* (Schrank, 1781)
    Tyroglyphus *lintneri* Osborn, 1893
    Tyroglyphus *americanus* Banks, 1906
    Tyroglyphus *longior* var. *castellanii* Hirst, 1912
    Tyroglyphus *australasiae* Oudemans, 1916
    Tyroglyphus *muscae* Sasaki, 1921
    Tyrophagus *muris* Oudemans, 1924
    Tyrophagus *vanheurni* Oudemans, 1924
    Tyrophagus *amboinensis* Oudemans, 1925
    Tyrophagus *bulleri* Volostschuck, 1936
    Tyrophagus *noxius* Zakhvatkin, 1936
    Tyroglyphus *longior* var. *taiwanensis* Sugimoto, 1938
    Tyroglyphus *nadinus* Lombardini, 1944
    Tyrophagus *brauni* Turk and Turk, 1957
    Tyrophagus *dimidiatus*, (Hermann) in Turk and Turk, 1957
12. *silvester* Zakhvatkin, 1941
    Tyrophagus *humerosus silvester* Zakhvatkin, 1941
13. *similis* Volgin, 1949

*Tyrophagus humerosus*, Oudemans in Zakhvatkin, 1941
*Tyrophagus infestans*, (Berlese) in Turk and Turk, 1957
*Tyrophagus oudemansi* Robertson, 1959
*Tyrophagus dimidiatus*, (Hermann) in Hughes, 1961

14. *tropicus* Robertson, 1959

15. *zachvatkini* Volgin, 1948

*Tyrophagus vjatshensis* Sorokin, 1952

As did Samsinak (6), the authors exclude from *Tyrophagus* the following: *Tyrolichus casei* Oudemans, 1910 (*Tyrolichus*); *Tyroglyphus neotropicalis* Oudemans, 1917 (*Povelsenia*); *Tyroborus lini* Oudemans, 1924 (*Tyrolichus*); *Forcellinia fungivora* Oudemans, 1932 (*Mycetoglyphus*); and *Tyrophagus rotundus* Turk and Turk, 1957 (? *Acoteledon*).

In addition to the species listed, several unrecognizable forms have been assigned to *Tyrophagus*. These are: *Acarus dimidiatus* Hermann, 1804; *Tyroglyphus breviceps* Banks, 1906; *Tyroglyphus coccophilus* Banks, 1906; *Tyroglyphus sacchari* Banks, 1917; *Tyroglyphus deliensis* Oudemans, 1923; and *Tyrophagus humerosus tesquorum* Zakhvatkin, 1941.

An introduction to the literature on the biology of *Tyrophagus* spp. may be found in the works of Zakhvatkin (11), Hughes (1), Robertson (5), and Kevan and Sharma (2).

Below is a translation (with some modifications) of Samsinak's (6) key to the species of *Tyrophagus*. To facilitate identification of species of special interest in agriculture, comparative figures of the aedeagi, dorsal setae, and *omega*, of these species are provided (Figs. 3A-3E, 3F-3I, 4A-4D). Because of reliance on relative lengths of the dorsal setae, couplets 3 and 4 of this key are rather weak. It has been noted that the dorsal setal patterns of males fit the criteria of the key better than those of females and therefore identifications are best based on males. It is likely that identification of females will be impossible in many cases.
KEY TO THE SPECIES OF *TYROPHAGUS*

Translated and modified from Samsinak (6)

1. *la* approximately twice as long as *d1*. Distance between *d2* large (usually two-thirds the distance between *d1*). Aedeagus short, arched. Supporting sclerites of aedeagus turned mediad. Supracoaxal seta lanceolate, with long setules; distal portion attenuate. Africa, New Guinea .................... *tropicus* Robertson

2. *d2* well over five times as long as *d1*. Supracoaxal seta densely setulose. Aedeagus short, beak-shaped. Placement of discs on tarsus IV of male dividing segment into three almost equal parts. Algeria .................... *miripes* Athias-Henriot

3. *d2* considerably (2.5-4.5 times) longer than *d1* .............................. 4

4. *d2* at most twice as long as *d1* .................................................. 7

5. *d2* considerably (2.5-4.5 times) longer than *d1* or *la*. Aedeagus short, thickened distally and terminated obliquely .............................. 5

6. *omega1* widened distally (slightly claviform) (Fig. 4B). Supracoaxal seta lanceolate, densely set with long setules, very attenuate distally. Aedeagus S-shaped (Fig. 3B). Aedeagal supporting sclerites turned laterad. Cosmopolitan (?) .................. .......................... 9

7. *omega1* long, thin, tapered distally (Fig. 4D). *d2* 1.3-2 times as long as *d1* (Fig. 3H). Aedeagus long, thin, clearly S-shaped (Fig. 3A). Aedeagal supporting sclerites turned mediad. Europe, Asia, New Zealand, North America ............ *longior* (Gervais)

8. *omega1* not tapered distally (comp. Figs. 4A-C) .................. 8
8. Supracoxal seta very short and entirely smooth. $d_1$, $d_2$, and $la$ almost equal in length (ca. 40 microns). Aedeagus straight basally, curved distally. Aedeagal supporting sclerites turned laterad. Ghana. ............................................ *brevicrinatus* Robertson Supracoxal seta always setulose. .................................. 9

9. $la$ slightly but definitely shorter than $d_1$. Aedeagus long, narrow (similar to that of *T. longior*). Supracoxal seta not lanceolate. Myrmecophilous. U.S.S.R., Czechoslovakia. .................................................. *zachvatkini* Volgin $la$ longer than $d_1$ ........................................... 10

10. $d_2$ twice or almost twice as long as $d_1$ (Fig. 3I). Aedeagus S-shaped. Supracoxal seta lanceolate, setulose, and distally attenuate .................................................. 11

$d_2$ about as long as $d_1$ (Fig. 3F) .................................. 12

11. $omega_1$ widened distally (claviform). Aedeagus S-shaped. Myrmecophilous (?). Java ................. *javensis* (Oudemans) $omega_1$ rod-shaped, not claviform (Fig. 4A) Aedeagus with distal half straight (Fig. 3D). U.S.A. .................. *neiswanderi* n. sp. 12

12. Supracoxal seta lanceolate, with long setules, and very attenuate distally. Placement of discs of tarsus IV of male dividing segment into three almost equal parts. Aedeagus short, arched or almost straight, and with rounded tip. Aedeagal supporting sclerites turned mediad. U.S.S.R. .................. *molitor* Zakhvatkin Supracoxal seta not lanceolate. Tarsal discs of male almost always in basal half of tarsus. ............................................. 13

13. Aedeagus slender, narrowed distally, and clearly S-shaped (Fig. 3E). U.S.S.R., Czechoslovakia, U.S.A. .......... *mixtus* Volgin Aedeagus not narrowed distally .................................. 14

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Fig. 1.—*Tyrophagus neiswanderi*. A. Genitoanal region of male. B. Supracoaxal region of leg I of male. C. $\omega_1$, $\omega_2$, and famulus of tarsus I of male. D. Tarsus IV of male, posterior (paraxial). A and D scale equals 50 microns. B scale equals 10 microns.
Fig. 2.—*Tyrophagus neiswanderi*, dorsal view of female. Scale equals 150 microns.
Fig. 3.—A-E. Aedeagi of (A) Tyrophagus longior (South Africa); (B) T. putrescentiae (Germany); (C) T. similis (California); (D) T. neiswanderi (Ohio); and (E) T. mixtus (New York). A, C, and E scale equals 15 microns. B and D scale equals 15 microns.

F-I. Dorsal setae d₁, d₂, and la of males of (F) T. similis (California); (G) T. putrescentiae (Ohio); (H) T. longior (France); and (I) T. neiswanderi (Ohio). F-I scale equals 50 microns.
Fig. 4.—A-D. Photomicrographs of omega, I of males of (A) *Tyrophagus neiswanderi* (Ohio); (B) *T. putrescentiae* (Germany); (C) *T. similis* (California); and (D) *T. longior* (Japan); all to same scale.
Fig. 4E.—Photomicrograph of recently laid egg of *T. neiswanderi*; to same scale as Fig. 4F.
Fig. 4F.—Photomicrograph of recently laid egg of *T. putrescentiae*; to same scale as Fig. 4E.