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A study of *Tetraneura* Hartig, 1841 (*Homoptera, Aphididae*), with descriptions of a new subgenus and new species

I. Introduction.

When soon after World War II a compatriot handed me some aphids taken from a gall on *Ulmus* in France it appeared that they could not be identified with the existing literature. The very large claws of the embryos in the alatae were also known from *Tetraneura hirsuta* (Baker), now *T. nigriabdominalis* (Sasaki), and the French material was identified as *T. hirsuta*. Later similar material came in from Yougoslavia, Hungary and Russia. But *T. hirsuta* had never been found on grass roots in Europe. Therefore I searched for *Tetraneura* in Italy, and indeed found a grass root aphid which had embryos strongly resembling those in the French emigrants from *Ulmus*. However, the Italian aphids differed in some small characters from *T. hirsuta,* and so did their embryos. Therefore experiments were made by my Hungarian and Russian colleagues, and the apterae produced by alatae from *Ulmus* galls were identical with the ones I found in Italy, much like *T. hirsuta* but just different. Then the search for the name began in earnest.

Colleagues from many countries helped with mounted specimens, pickled samples from galls, or even full galls. It appeared, as Eastop (1966) showed, that apterous exules of *Tetraneura* from grass roots can be distinguished by their morphology. But alatae can in many cases not be identified, certainly not by the characters used by Mordvilko (1935). Eastop (1966) published an excellent key to the alatae which he had. But evidently he could not separate species like the mentioned European *Tetraneura* from *Ulmus,* and *Tetraneura hirsuta.*

II. Embryos and first instar larvae.

Methodical studies of embryos dissected from, or inside emigrants from *Ulmus* or virginoparae from grasses were more promising. Though Zwölfer (1957) has demonstrated that length of hairs may vary enormously in embryos of the same species, the setal pattern, the wax glands, the length and chaetotaxy of the last rostral segment and several other characters appear to be very nearly constant. And these characters are also the same in embryos from emigrants from galls, and in embryos from progeny of such emigrants on grass roots in those species of which material is available from transfer experiments. Therefore I ventured to identify some material from *Ulmus* with other material from grass roots in cases in which no transfer experiments have been made. Experimental work in Pakistan and Japan must be done to check my suggestions.

Too late I discovered another method for the classification of *Tetraneura*'s in their galls. In a Japanese gall I found a very small black object which after clearing appeared to be the cast skin of the first instar larva of the fundatrix, a most remarkable structure very different from any other embryo or first instar larva of a *Tetraneura*. Every gall which I still had contained such a cast skin, remarkably well preserved and very easy to find. Within the species these exuviae showed very little variation, but those of *T. nigriabdominalis* (Sasaki) differ strikingly from those of *T. yezoensis* Mats., the only ones I could examine.

Embyros inside sexuparae probably could be classified although they offer not much foothold. I did not have enough material to try. It should be emphasized that these embryos differ very much from those inside virginoparae, and that none of the characters used in the key to embryos can be applied to embryos in sexuparae. Consequently I could not with certainty identify all sexuparae collected from the bark of *Ulmus* outside Europe.

Because emigrants from galls may be packed with mature embryos, it is often difficult to examine all details through the abdominal skin of the mother. After clearing, one can easily separate the mother's thorax and abdomen and squeeze the embryos out in a very thin layer of the mounting medium. Slides can be opened, and the embryos dissected from the body of the mother, preferably after brief treatment with 10% KOH and chloralphenol. This greatly facilitates examination of the chaetotaxy, and wax glands.

III. Alate females.

In most species of which both morphs are known, emigrants differ very strongly from sexuparae, in almost unpredictable ways. Interrelations of antennal segments and their sensoriation, chaetotaxy of the head as used by Eastop (1966), structure and chaetotaxy of the last rostral segment, presence or development of wax glands, and several other characters may be quite different in these morphs, as the description of *T. yezoensis* shows. All known sexuparae have siphunculi, but these may also occur in emigrants from galls on *Ulmus*.

In this context reference must be made to Zwölfer's remarks on *T. personata* Börner, which Börner (1950) separates from emigrants of *T. ulmi* by the brownish colour of the abdomen and the presence of siphunculi. The offspring of the *T. personata*-like specimens is indistinguishable from what Börner would call *T. ulmi,* a dark green insect. This offspring is never green, usually reddish, and it always has siphunculi. Zwölfer suggests that *T. personata* is nothing but *ulmi*, but with the characters of the next generation shifted one generation backwards. If this phenomenon occurs also in other *Tetraneura* species, then the presence or absence of siphunculi in emigrants from galls cannot be used as a taxonomic discriminant. The described emigrants of *T. yezoensis* and *T. radicicola* differ in this respect. Embryos inside « *personata* » alatae are not basically different from those inside « *ulmi* » alatae.

The differences within the species between alate virginoparae from grass roots and sexuparae are mostly small. Sexuparae often have larger wax glands, and on the average longer antennae and more rhinaria. Intermediates with both rostrate and arostrate embryos occur.

IV. Apterous exules.

The number of antennal segments may greatly vary within the species. Specimens with 6 segments may occur but are uncommon. Various types of fusion of segments occur, with or without vague traces of segmentation, such as (III + IV + V + VI), (III + IV + V) + (VI), (III + IV) + (V) + (VI), all rather common in some species, but also (III + IV) + (V + VI). Mostly « segment VI » is the last to coalesce completely. The original position of the segmental borders can always be deduced from the chaetotaxy of the flagellum in comparison with the chaetotaxy in embryos. In the measurements the actual number of segments of the specimens is given, not the theoretical number.

V. Classification.

On the basis of the hind tarsal claws in embryos a division of the genus into two subgenera in proposed. From the available, incomplete material it would seem that these subgenera also will differ in the presence or absence of a type of very large marginal wax glands in alatae born on grasses. In both subgenera the number of dorsal hairs on the abdomen shows great variation, especially the number of marginal hairs, which for adherents of orthodox Börnerian aphid taxonomy may be a temptation to erect more subgenera or even genera.

The described species are grouped as follows:

1. Subgenus *Tetraneura* Hartig, 1841, type-species *Aphis gallarum* Gmelin, 1790 (= *Tetraneura ulmi* [L., 1758]). Hind tarsal claws in embryos inside emigrants or exules not enlarged (0.05 mm long or shorter), not much larger than claws on other tarsi; much shorter than the tarsal joint to which they are attached in first instar larvae. The following described taxa belong here: *Tetraneura aegyptiaca* Theob., 1922; *T. africana* v.d. Goot, 1912; *Endeis bella* Koch, 1857; *Pemphigus boyeri* Pass., 1856; *P. caerulescens* Pass., 1856; *Tetraneura cynodontis* Theob., 1922; *Amycla fuscifrons* Koch, 1857; *Aphis gallarum* Gmelin, 1790; *Tetraneura heterohirsuta* Carver & Basu, 1961; *Tycheoides longisetosa* Dahl, 1912; *Tetraneura paiki* spec. nov.; *Byrsocrypta personata* Börner, 1950; *Tetraneura radicicola* Strand, 1929; *Endeis rosea* (or *rorea* or *rosae*) Koch, 1857; *Tetraneura rubra* Licht., 1880; *T. takahashii* Mordv., 1930; *T. theobaldi* Zwölfer, 1958; *Aphis ulmi* L., 1758; *Tetraneura ulmifoliae* Baker, 1920; *T. ulmisacculi* Patch, 1910; *T. yezoensis* Mats., 1917.

2. *Tetraneurella* subgen. nov., type-species *Dryopeia hirsuta* Baker, 1921 (almost certainly a synonym of *Schizoneura nigriabdominalis* Sasaki, 1899, of which, however, no authentic material is left). Hind tarsal claws in embryos inside emigrants from *Ulmus* and virginoparous exules greatly enlarged (at least 0.06 mm long), often more than 1½ times as long as mid tarsal claws; at least as long as, and usually longer than, the tarsal joint to which they are attached in first instar larvae. Described taxa that belong here: *Tetraneura akinire* Sasaki, 1904; *T. basui* spec. nov.; *T. chinensis* Mordv., 1924; *T. cynodontis coimbatorensis* George, 1927; *T. fusiformis* Mats., 1917; *Dryopeia hirsuta* Baker, 1921; *Tetraneura javensis* v.d. Goot, 1917; *Schizoneura nigriabdominalis* Sasaki, 1899; *Tetraneura*

oryzae v.d. Goot in v. Heurn, 1923; *T. polychaeta* spec. nov.; *T. sorini* spec. nov..

Several of these names are synonyms as has been pointed out by earlier workers, but others have been erroneously synonymized.

VI. Geographical distribution.

Tetraneura's are known from all continents, but this distribution is almost certainly not natural. America has *T. ulmi* (L.), locally known as *T. ulmisacculi* Patch, and *T. nigriabdominalis* (Sasaki), recorded as *T. hirsuta* (Baker). Both are almost certainly introduced.

Australia has three species, only found on grass roots, but they probably originate from Eastern Asia (Japan) where they would seem to produce galls on *Ulmus*. This distribution may be natural, for the species can fly from grass to grass, and do not need *Ulmus* for their subsistence if the climate helps. In any case there is not the slightest need to accept Mordvilko's (1935) theories on anholocyclic aphids, and to invoke extinct *Ulmus* species or formerly much larger territories of recent *Ulmus* species for explaining the occurrence of *Tetraneura* species thousands of miles from the area where they overwinter as eggs on *Ulmus*. He did not realize the distances over which an alate aphid can be transported by wind in one jump, let alone the combined jumps during centuries.

Africa has two species in common with Europe, both apparently restricted to North Africa, and one species of presumably Oriental origin.

In Europe so far four species have been found. All of these occur at least as far East as Iran and Turkestan, and one, *T. akinire,* is also known from Japan. *T. ulmi* has been reported from Siberia, China, Indonesia, and Japan, but this has to be confirmed by the examination of embryos. Mordvilko's (1935) records of *T. ulmi* are certainly suspect, for he thought that *T. yezoensis* from Japan and *T. javensis* from Indonesia are synonyms of *T. ulmi.*

Summarizing we can conclude that *Tetraneura* is originally a Palaearctic genus, associated with Palaearctic species of *Ulmus,* and transported by wind and human agency to other Regions.

VII. KEY TO EMBRYOS IN EMIGRANTS FROM GALLS AND VIRGINOPAROUS EXULES ([1]).

1 (14) Embryos with enlarged hind tarsal claws, the longest at least 0.060 mm long. In first instar larvae these claws at least as long as the tarsal joint (fig. 5). Subgenus **Tetraneurella** subgen. nov.

2 (11) On abd. tergites I-V marginal hairs in single pairs (fig. 52). Ventro-lateral wax glands consisting of a group of cells with or without additional minute cells.

3 (4) Ant. segment IV with only 4 hairs. Both spinal and marginal hairs on abd. tergites I-V very thick (0.004-0.005 mm at base) and long, but pleural hairs less than half as thick and long.

T. (T.) basui spec. nov.

4 (3) Ant. segment IV with at least 10 hairs. Spinal and pleural hairs on abd. tergites I-V of about the same shape, but marginal hairs usually much stouter.

5 (6) Tarsi completely smooth. Abd. tergites I-V with 7-9, rarely 6, spinal and pleural hairs, tergite VII with in total 6 hairs.

T. (T.) akinire Sasaki

6 (5) Tarsi spinulose (fig. 9). Abd. tergites I-V with 4-6 spinal and pleural hairs, tergite VII with in total 4 or 6 hairs.

7 (8) Abd. tergites I-V with 4 spinal and pleural hairs, and 2 large marginal hairs. Ventro-lateral glands consisting of clusters of one type of cells with lumina of 0.004-0.011 mm in diameter.

T. (T.) sorini spec. nov.

8 (7) Abd. tergites I-V with normally 6 spinal and pleural hairs (fig. 56). Ventro-lateral wax glands consisting of a cluster of cells with lumina of much less than 0.003 mm in diameter, and of mostly almost invisible minute cells between the larger ones and the periphery of the gland. Complex of *T. (T.) nigriabdominalis* (Sasaki).

9 (10) Abd. tergite VII with in total 4 hairs, 2 spinal ones and 2 marginal ones (fig. 56).

T. (T.) nigriabdominalis subsp. **bispina** subsp. nov.

10 (9) Abd. tergite VII with in total 6 hairs, 2 spinal ones, 2 pleural ones and 2 marginal ones.

T. (T.) nigriabdominalis (Sasaki)

([1]) Not keyed: *T. paiki* spec. nov.

11 (2) On abd. tergites I-V marginal hairs not in single pairs but in groups of 4-10 hairs of which mostly one is larger than all others (fig. 58). Ventro-lateral wax glands consisting of one large cell with or without additional minute cells.

12 (13) On the hind tarsi one claw 1 1/3 - 1½ times as long as the other (fig. 2). Tarsi markedly spinulose. Spinal and pleural wax glands on abd. tergites I-V absent or not larger than the papilla of a dorsal hair, at most 0.004 mm in diameter.

T. (T.) javensis v.d. Goot

13 (12) Hind tarsal claws hardly different in length (fig. 1). Tarsi quite smooth. Spinal and pleural wax glands on abd. tergites I-V rather large, 0.016 mm in diameter or larger, consisting of a single stippled cell.

T. (T.) polychaeta spec. nov.

14 (1) Embryos with hind tarsal claws of less than 0.050 mm long. In first instar larvae these claws distinctly shorter than the tarsal joint (fig. 7). Subgenus **Tetraneura** Hartig.

15 (20) Marginal hairs on abd. segments I-V in single pairs (fig. 55).

16 (19) Ventro-lateral glands on abd. segments I-V consisting of a large central cell surrounded by a closed ring of small cells (fig. 21).

17 (18) Marginal hairs on abd. tergites I-V much longer and stouter than the single pair of pleural hairs (fig. 55). Small cells of the ventro-lateral wax glands on tergites I-V with their long axis parallel to the periphery of the central cell. Spinal and pleural wax glands much smaller than the ventro-lateral glands.

T. ulmi (L.)

18 (17) Marginal hairs on abd. tergites I-V similar to the pleural hairs (fig. 54). Small cells of the ventro-lateral wax glands of tergites I-V isodiametric or with their long axis at right angles to the periphery of the central cell. Spinal and pleural wax glands similar to the ventro-lateral ones.

T. caerulescens (Pass.)

19 (16) Ventro-lateral wax glands consisting of a cluster of mutually similar cells, not with a central cell.

T. (T.) sorini spec. nov.

20 (15) Marginal hairs in groups in which often one hair is much larger than the others (fig. 59).

21 (22) Ventro-lateral wax glands of abd. tergites I-V consisting of a group of some 20-30 equally large cells, or of cells surrounding a partly subdivided central cell (fig. 22).

T. africana v.d. Goot

22 (21) Ventro-lateral wax glands consisting of one more or less crenulated large cell with sometimes a few (1-5) minute cells scattered around the periphery of the large cell (fig. 20). Complex of *T. yezoensis* Mats.

23 (24) Abd. tergites I-V with about 8-20 spinal and pleural hairs, more or less in a single transverse file. Ant. segment IV with about 16-20 hairs. Last rostral segment with 10-12 hairs besides the 3 subapical pairs.

T. yezoensis Mats.

24 (23) Abd. tergites I-V with about 22-50 spinal and pleural hairs in irregular pattern. Ant. segment IV with 30-55 hairs (fig. 60). Last rostral segment with about 20-24 hairs besides the 3 subapical pairs.

T. radicicola Strand

VIII. Key to apterous exules ([2]).

Note. In the same species one may find apterous exules with 3, 4, 5, or 6 antennal segments. The 2 basal segments, and usually the segment bearing the most distal primary rhinarium are free. The number of hairs on the antennae in the following key relates to the hairs on the part between the 2nd segment and the distal rim of the penultimate primary rhinarium.

1 (4) Not more than 7 antennal hairs (see note) present.

2 (3) Spinal and pleural wax glands on abd. tergites I-V (0.052-0.065 mm in diameter) consisting of a large (0.025 mm in diameter) central cell surrounded by a single or partly duplicated ring of rather smaller (0.008-0.013 mm diameter) cells. Abd. tergite VII with 4-6 hairs. Longest hair on penultimate ant. segment not longer than largest diameter of the segment.

T. caerulescens (Pass.)

3 (2) Spinal and pleural wax glands on abd. tergites I-V erratic and very small (0.016-0.025 mm diameter), consisting of one or a few larger cells (0.006-0.009 mm diamete) and a few very small cells (less than 0.004 mm diameter). Abd. tergite VII with 8 hairs. Longest hair on penultimate ant. segment nearly twice as long as largest diameter of the segment (fig. 46).

T. (T.) basui spec. nov.

4 (1) More than 8 antennal hairs present (see note).

([2]) Not keyed: *T. paiki* spec. nov., *T. polychaeta* spec. nov., *T. sorini* spec. nov.

5 (8) Dorsum of abdominal tergites I-V evenly covered with very fine hairs that marginally are about 0.070 mm long. Besides those there are on the posterior tergites 0-5 pairs of very long but rather slender marginal hairs of some 0.20 mm long. All abdominal wax glands roundish and apparently consisting of a single stippled cell. When 5 antennal segments are present, segment III with some 16-45 hairs.

6 (7) When 5 antennal segments are present, segment IV with about 18-27 hairs.

T. yezoensis Mats.

7 (6) When 5 antennal segments are present, segment IV with some 37-60 hairs.

T. radicicola Strand

8 (5) Hairs on abdominal dorsum often in single transverse rows, sometimes very short. Mostly also on more anterior abdominal tergites very long or stout marginal hairs present. Abdominal wax glands composite, usually consisting of a mixture of smaller and larger cells. When 5 antennal segments are present, segment III with 0-12 hairs, and if only 4 segments are present, segment III with at most about 25 hairs.

9 (10) Marginal or ventro-lateral wax glands, especially those on tergite VII consisting of numerous (e. g., 5-30), mostly about equally large cells. Antennal hairs considerably less than half as long as maximum diameter of segment IV; segment III (in specimens with 5 ant. segments) with 5-9 hairs near apex.

T. africana v.d. Goot

10 (9) Wax glands composed in a different way, or else very long, very stout marginal hairs present on abdominal segments I-VII. Antennal hairs as in 9 (10) or longer; segment III in specimens with 5 ant. segments with 0-6 hairs.

11 (12) All abdominal wax glands composed of a large round or strongly transverse, sometimes subdivided central cell surrounded by a single or partly double ring of small cells. Abd. tergite VIII with only 2, long hairs; subanal plate only with 5-6 long hairs, not with additional small hairs (not counting those on the 2 large rudimentary gonapophyses) ([3]).

T. ulmi (L.)

([3]) Exules of *T.* (*T.*) *sorini* spec. nov. are not known but they may well have only 4 long hairs on the subanal plate, in combination with the wax glands of *T. nigriabdominalis*.

12 (11) Abdominal wax glands not with a central cell completely surrounded by small cells. Abd. tergite VIII with more than 2 hairs; subanal plate normally with more than 6 hairs (not counting those on the rudimentary gonapophyses). On all abdominal segments very long and stout marginal hairs.

13 (14) Wax glands on abdomen consisting all or partly of one large cell, and many small cells in a group; the larger cell either quite excentrally, or with on two opposite sides of the large cell groups of small cells (figs. 13-15).

T. (T.) javensis v.d. Goot

14 (13) Wax glands of one cell, or composed (on posterior abdominal tergites) of a group of about equally large cells, with or without a small group of very small cells.

15 (16) Abd. tergite VIII commonly with some small marginal hairs in addition to the 2 very stout hairs.

T. (T.) akinire Sasaki

16 (15) Abd. tergite VIII only with 2 very stout hairs, not with additional hairs.

T. (T.) nigriabdominalis (Sasaki) *sensu latiore*

17 (18) Tergite VII with only two spinal hairs similar to the marginal ones. Mostly some of the spinal or pleural hairs on the anterior abd. tergites rather stout and over 0.030 mm long. Disc of subanal plate with 4 stout and 8-16 thin hairs.

T. (T.) nigriabdominalis bispina subspec. nov.

18 (17) Tergite VII with 4-6 hairs besides the marginal hairs. Spinal and pleural hairs on the anterior abd. tergites very short, to 0.025 mm. Disc of subanal plate with 4 stout and 15-50 thinner hairs.

T. (T.) nigriabdominalis (Sasaki) *sensu stricto*

IX. Key to sexuparae

(containing embryos without mouth parts).

1 (6) Marginal glands on abdominal segments I-VII consisting of 15 or more cells of similar size and structure, all similarly pale (fig. 10). Last rostral segment shorter than second joint of hind tarsi.

Tetraneurella subgen. nov.

2 (3) Subanal plate only with 4-6 large hairs besides the hairs on the rudimentary gonapophyses (fig. 50).

T. (T.) sorini spec. nov.

3 (2) Subanal plate with a number of hairs in addition to those mentioned sub 2(3) (fig. 51).

4 (5) Subanal plate densely covered with about 40-100 fine hairs, besides 4 stouter hairs and those on the rudimentary gonapophyses.

T. (T.) akinire Sasaki

5 (4) Subanal plate with about 18-28 fine hairs, besides 2-4 stouter hairs and those on the rudimentary gonapophyses.

T. (T.) nigriabdominalis (Sasaki)

6 (1) Marginal glands on abd. segments I-VII not consisting of 15 or more cells all of the same type; sometimes there are only single crenated cells with or without a few minute cells, sometimes especially on segment VII there is a central, occasionally subdivided, central cell, surrounded by smaller cells, or a central group of cells has a pigmentation differing from peripheral cells. Last rostral segment shorter or longer than second joint of hind tarsi.

Tetraneura Hartig *sensu stricto*

7 (14) All marginal glands in principle consisting of a single crenulated cell with sometimes 1-3 minute cells against its periphery, but sometimes the single cells subdivided, and then head often with very many, 30 or more dorsal hairs, and last rostral segment often with 12 or more hairs besides the 3 subapical pairs. Group of *T. yezoensis* Mats.

8 (9) Ant. segment II with only 3-5 stout hairs. Dorsum of head with about 14-16 hairs. Last rostral segment nearly as long as second joint of hind tarsi with 5 or 6 hairs besides the 3 subapical pairs. Abd. tergite VII in total with only 4 hairs.

T. paiki spec. nov.

9 (8) Ant. segment II with 10 or more hairs. Dorsum of head with more than 25 hairs. Last rostral segment about 1½ times as long as second joint of hind tarsi, with 12 or more hairs besides the 3 subapical pairs. Abd. tergite VII with many hairs, especially marginally.

10 (13) Last rostral segment with about 12-21 hairs besides the 3 subapical pairs. Ant. segment V with 19-32 hairs.

11 (12) Last rostral segment with 14-21 hairs besides the 3 subapical pairs. Ant. segment III with 9-14 rhinaria. Tergite VIII with 4 hairs, tergite VII with 4-8 spinal and pleural hairs and several marginal hairs.

T. yezoensis Mats.

12 (11) Last rostral segment with 12 hairs besides the 3 subapical pairs. Ant. segment III with about 22 rhinaria. Tergite VIII with 2

hairs, tergite VII with only 2 spinal hairs, without pleural hairs, but with many marginal hairs.

? **T. polychaeta** spec. nov.

13 (10) Last rostral segment with 24-32 hairs besides the 3 subapical pairs. Ant. segment V with 40-65 hairs.

T. radicicola Strand

14 (7) Marginal glands in principle consisting of a central cell surrounded by smaller cells, especially on segment VII, but sometimes the central cell completely or incompletely subdivided.

15 (16) Last rostral segment not longer than second joint of hind tarsi. Ant. segment V less than 1½ times as long as segment VI.

T. caerulescens (Pass.)

16 (15) Last rostral segment at least 1¼ times as long as second joint of hind tarsi. Ant. segment V at least 1 2/3 times as long as segment VI.

17 (18) At least some of the marginal wax glands on abd. segments I-V consisting of a large, not subdivided, central cell in a ring of smaller cells. Tergite VIII only with 2 stout hairs.

T. ulmi (L.)

18 (17) Marginal wax glands on abd. segments I-V seemingly consisting of one type of small cells, but the inner ones differently pigmented. Tergite VIII normally with 4 stout hairs.

T. africana v.d. Goot

X. Descriptions of the species.

Tetraneura africana v.d. Goot, 1912

1913. Van der Goot, P., Mitt. Naturhist. Mus. Hamburg, 29 : 282-283, *Tetraneura africana.*
1923. Theobald, F. V., Bull. Soc. R. Ent. Egypte, 15 : 66-70, *Tetraneura cynodontis.*

Apterous viviparous female (exules).

Body large, about 2.50-3.25 mm long. Spinal and pleural hairs on anterior abd. tergites thin and very short, rarely over 0.009 mm long, not numerous, 2-4 per (0.1 x 0.1) mm^2; one or more pairs of the marginal hairs on the posterior tergites, and a pair of spinal hairs on tergite VII to 0.065 mm long and much stouter; tergite VII with 8-12 very small hairs besides the mostly rather stout spinal hairs; tergite VIII with 2 long hairs of

0.15-0.18 mm long and, usually in between, 2-8 shorter hairs of 0.10-0.15 mm long. Antennae of 5 segments with mostly very distinct segmentation, not spinulose, about 1/6 of length of body; segment I with 3-4 short hairs of about 0.010 mm long, and the dorsal one on basal half to 0.016 mm long; segment II with 3-5 short hairs; segment III on basal half hairless, on distal half with 5-9 hairs; segment IV with 9-17 small hairs, 1 - 1 5/8 times as long as III. Last rostral segment about 0.18-0.23 mm long, with 14-18 short (0.080-0.013 mm) thorny hairs besides the 3 much longer subapical pairs. Wax glands very distinct, seemingly composed of isodiametric cells of one type, but actually with two types of cells: smaller cells, sometimes absent or seemingly in the rim of the gland, with a dark stippled lumen, and larger cells with a pale stippled lumen. Head on the underside with two glands 0.030-0.040 mm in diameter, composed of 5-8 cells with some minute ones in the rim, on the front with 2 small ones (1-3 cells each) and on vertex with 2-4 mostly abortive ones of 4-8 cells; ventro-lateral glands from pronotum (e.g., 0.075 mm in diameter, 20 cells) to abd. segment IV decreasing in size to 3-5 cells, with against the rim a few minute cells that are easily overlooked; increasing in size towards tergite VII on which a very elongate irregular group of clear large type cells is at both ends, or completely, surrounded by a group of hardly smaller darker small type cells; ventro-lateral gland on VI less elongate with a more compact central group of large type cells; spinal and pleural glands circular, small (0.013-0.025 mm in diameter), consisting of 1-4 large type cells, often without small cells. Tibiae very thick, 0.085-0.100 mm in the middle. Cauda with 2-4 hairs. Subanal plate with 6-10 long stout hairs besides the smaller ones on the gonapophyses.

Measurements in mm.

No.	Length body	Ant.	Antennal segments		
			III	IV	V
1	2.87	0.45	0.11	0.12	0.07
2	3.31	0.50	0.12	0.14	0.08
3	2.51	0.46	0.09	0.14	0.08
4	2.87	0.47	0.10	0.14	0.08
5	2.81	0.47	0.10	0.15	0.09
6	2.61	0.40	0.09	0.12	0.08
7	2.72	0.49	0.11	0.16	0.08
8	2.68	0.48	0.10	0.15	0.09

(1-2, from *Cynodon dactylon,* Giza, Egypt, 15.II.'57, leg. M.S. Hassan, C.I.E. no. 15648; 3-6, from *Cynodon dactylon,* Rehovoth, Israel, 16.III.'51, leg. I. Harpaz no. 5187; 7, from *Cynodon,* Ispahan, Iran, XII.'54, leg. A. Davatchi, Remaudière no. i 1364; 8, grass roots, Ahwaz, Iran, 25.III.'60, leg. R. v.d. Bosch no. IR 20).

Alate viviparous female (sexuparae).

Head with about 30 short (0.016 mm) hairs; chaetotaxy of abdomen as in apterous exules but spinal and pleural hairs just longer, and the marginal hairs shorter; tergite VII with in total 14 hairs. Antennae in available specimen with incomplete fusion of III and IV, with segment V only on distal half distinctly spinulose; segment III with 11-12 unusually broad rhinaria and 5-7 hairs; segment IV with 4-5 rhinaria and 3-4 hairs; segment V with 7-8 rhinaria and 14-20 hairs ([4]). Last rostral segment 0.22 mm long, nearly 1½ times as long as 2nd joint of hind tarsi. Wax glands basically as in apterous exules, but smaller, and on abd. segment VI and VII with the subdivision of the large central cell (vide discussion) mostly incomplete; no trace of very large and indistinct marginal glands on abdomen. Legs normal; tibiae only at the apex spinulose; dorsal hairs halfway hind tibiae adpressed, about 0.020-0.024 mm long. Subanal plate with 7 hairs besides those on the gonapophyses. The rest as in apterous exules.

Measurements in mm.

No.	Length body	Ant.	Antennal segments				Rhin. on segments		
			III	IV	V	VI	III	IV	V
1	2.72	0.70	0.18	0.07	0.18	0.09	11 & 12	4 & 5	7 & 8

(paratype of *T. cynodontis* Theob., from *Cynodon dactylon,* Gizeh, 20.III.'18 ([5]), leg. F.C. Willcocks, B.M. no. 1954-143).

Embryos taken from apterous exules, or larvae I (fig. 59).

Antennae of 5 segments (fig. 38); segment V wholly, segment IV dorsally apically, and ventrally over distal 1/2-2/3 spinulose. Segment I with 3 strong hairs of 0.040-0.060 mm long and one small hair of 0.006 mm long; segment II with 3 stout hairs; segment III with 0-3 smaller hairs of 0.028-0.045 mm long, segment IV with 11-17 hairs of 0.038-0.065 mm long; primary rhinarium with 3-branched, rarely 2-branched membrane. Last rostral segment when stretched about 0.22 mm long, with 14-17 hairs of similar size as the 3 subapical pairs. Marginal hairs seemingly in single pairs, but on tergites I-V actually in groups of one stout, caudad longer,

([4]) Original description of *T. cynodontis* mentions 7-10 rhinaria on III, 3-4 on IV, 8-10 on V.

([5]) Original description mentions 1.III.'18.

thorny hair of 0.020-0.091 mm long with rarely 1 or 4, usually 2 small hairs of 0.009-0.015 mm long; tergite VII with 4 long hairs and 4-6 small ones; tergite VIII with 2 very long hairs with 2 shorter ones in between. Cauda with 2 hairs. Subanal plate with 6 long hairs. Wax glands of two types of cells, but the large type cells are part of one very large subdivided central cell as visible in the ventro-lateral glands on abd. segment I or mesothorax; here the subdivision is incomplete or merely indicated; small type cells may occur without large type cells. Head with 2 ventral glands of 3-6 large cells surrounded by a single closed ring of small cells, with 2 frontal glands and 4 on vertex composed of 1, or 2, large type cells enclosed by small ones; pronotum with 2 spinal glands with a core of 3-4 large type cells surrounded by a nearly everywhere double or triple layer of small cells, and with very elongated oval ventro-lateral glands of 14-17 often incompletely separated large type cells incompletely surrounded by small cells; mesonotum with 2 small large type cells with a double or triple layer of small cells; more caudad spinal glands becoming smaller, and both the large type cells smaller and small type cells fewer in number, the ventro-lateral glands more round and with single or nearly single layers of small cells (fig. 22); from mesothorax to abd. segment VI dorsad of the ventro-lateral glands and just below the line connecting the large marginal hairs a row of glands homogeneously composed of some 20 small type cells. Hind tarsal claws 0.045-0.055 mm long. Hind tarsi 0.080-0.095 mm long, spinulose like other tarsi and like distal 1/3 of the tibiae (fig. 6).

Discussion. MORDVILKO (1935) first suggested that *Tetraneura cynodontis* Theobald, 1923 was a synonym of *Tetraneura africana* v.d. Goot, 1912. The large apterous exules can easily be recognized by the seemingly homogeneous, transverse ventro-lateral glands on abdominal tergite VII. In the description of the embryos it is shown that these glands are not really homogeneous, but developed from a large central cell surrounded by small cells, rather as in *Tetraneura ulmi* or *T. caerulescens.*

As yet no material from galls on *Ulmus* is available that could be considered to be this species. MORDVILKO (1935) wrote that Silvestri sent him sexuparae collected from *Ulmus* trunks near Naples in Italy. Nearly all the material from identified grasses that I have seen came from *Cynodon dactylon,* but MORDVILKO (1935) records it from Southern Russia from *Calamagrostis,* and from Turkestan from *Andropogon halepense.*

Through the kindness of Dr. Szelegiewicz I could examine a specimen identified by the late Dr. S. Huculak and collected by L. Olesinski on 1.X.1967 from the roots of *Calamagrostis epigeios* at Chrzanov, Poland.

This specimen is much smaller than all other material I saw, it has some more hairs on the VIIIth abd. tergite, 10 instead of the usual 6 and the wax glands on tergite VII look rather different. They consist of a central elongated group of 6-8 rather large cells, and a very great number of not much smaller cells with completely clear lumen surrounding in a double layer the set of larger cells. In all other respects the specimens are similar to those from Southern areas.

WEIDNER & WAGNER (1968) state that all the microscopical slides in the Zoological Museum Hamburg were destroyed by fire, but that specimens examined by Van der Goot are still preserved in spirits. It appeared that only two were left, an adult aptera and one large larva. These were mounted, but clearing failed because of extreme fixation of the specimens, and the adult fell apart in the slide. One large embryo could be extracted separately. All relevant details such as wax glands, antennal hairs and chaetotaxy are clearly visible in the poor mount of the embryo, and MORDVILKO's synonymy is undoubtedly correct.

T y p e s. Hololectotype: Apterous viviparous female, from unknown host, Cairo, Egypt, May 1896, leg. Michaelsen. Embryo taken from type specimen also labelled hololectotype, on separate slide. In the Zoological Museum, Hamburg, Germany. Paralectotype: larva with data as for hololectotype in the author's collection.

Types of *Tetraneura cynodontis* Theobald in Brit. Mus. (Nat. Hist.), London.

Tetraneura (Tetraneurella) akinire Sasaki, 1904

1904. Sasaki, C., Zool. Magaz. Tokyo Zool. Soc., 16 : 403-405, *Tetraneura akinire.*

F u n d a t r i x.

Body nearly globular, about 1.30-1.65 mm long, without wax glands, on abd. segment I-V with single, rather stout, halfway their length often suddenly thinner, marginal hairs of 0.065-0.105 mm long; single pairs of spinal and erratic pleural hairs thinner than the marginal ones, but not much shorter; tergite VII with 4 stout hairs; tergite VIII with 2 hairs. Antennae normally of 3 segments, but sometimes an incomplete division between the two primary rhinaria. Last rostral segment 0.082-0.095 mm long, with 2-4 hairs besides the 3 subapical pairs. Subanal plate with 4 long hairs near the anus and some 10-30 between those and the rudimentary gonapophyses.

Measurements in mm.

No.	Length body	Ant.	Ant. segments	
			III	IV
1	1.50	0.18	0.12	
2	1.37	0.19	0.12	
3	1.34	0.19	0.12	
4	1.38	0.22	0.14	
5	1.50	0.19	0.11	
6	1.38	0.20	0.09	0.02

(1-2, from *Ulmus foliacea,* Suchumi, Georgia, U.S.S.R., 5.VI.'59, leg. A. Dzhibladze; 3, from *U.* sp., Yougoslavia, 25.VI.'62, leg. N. Tanasijevic; 4, from *U. campestris,* Baranya Megye, Hungary, 5.VI.'61, leg. P. Andrasfalvy; 5, from *U. parvifolia,* Kuroyama, Osaka, Japan, 27.V.'66, leg. M. Sorin gall 507; 6, from « Akinire » (is *U. parvifolia*), Fukuoka, Japan, 15.V.'64, leg. R. van den Bosch).

Apterous viviparous female (2nd generation, from one specimen).

Body slightly more oval than in fundatrix. Dorsal hairs more numerous. Wax glands very distinct, on abdomen in 6 longitudinal rows, roundish, consisting of only one type of equally small cells, of which there are about 15-20 in the spinal and marginal glands, 6-10 in the pleural glands. Antennae much longer than in fundatrix, of 6 distinct segments; for interrelation of segments vide measurements; primary rhinaria both fringed, the one on segment VI not in terminal position so that a short processus terminalis, of 1/5 the length of the segment, is present. Eyes with about 20 indistinct ommatidia besides the triommatidion. Siphunculi absent. Subanal plate with about 20 small hairs besides the many on the rudimentary gonapophyses. Other characters more or less as in fundatrix.

Measurements in mm.

No.	Length body	Ant.	Antennal segments			
			III	IV	V	VI
1	1.66	0.36	0.07	0.03	0.10	0.05

(from *Ulmus foliacea,* Suchumi, Georgia, U.S.S.R., 5.VI.'59, leg. A. Dzhibladze).

Alate viviparous female (emigrants from gall).

Body about 1.35-2.20 mm long. Head capsule with about 28-34 hairs of 0.013 (ventrally) to 0.035 (frontally) mm long. Antennae about 1/3 of length of body, with segment V-VI spinulose; segment I with 2-4 hairs of 0.022 mm long and one short hair; segment II with 2-6 hairs; segment III with 10-17 rhinaria; segment IV with 2-4 rhinaria; segment V with 5-12

rhinaria (fig. 25). Last rostral segment about 0.080-0.085 mm long, with 2-4 hairs besides the 3 subapical pairs, 1/2 - 6/11 of second joint of hind tarsi. No traces of wax glands. Legs rather slender; dorsal hairs halfway hind tibiae rather adpressed, 0.016-0.022 mm long. Wings with the stigma greyish brown with a broad dark border. Siphunculi absent in all specimens examined. Abdominal tergite VIII with 2 long hairs and more laterad 2-8 shorter hairs. Cauda with 2, rarely 3 hairs. Subanal plate with 4 long hairs and about 18-30 smaller hairs besides those on the gonapophyses.

Measurements in mm.

No.	Length body	Ant.	Antennal segments				Rhin. on segments		
			III	IV	V	VI	III	IV	V
1	1.39	0.48	0.16	0.05	0.14	0.05	10 & 11	3 & 3	6 & 6
2	1.45	0.52	0.18	0.06	0.15	0.05	10 & 11	2 & 3	5 & 6
3	2.17	0.65	0.22	0.07	0.16	0.09	12 & 14	3 & 4	7 & 7
4	1.86	0.62	0.21	0.07	0.16	0.07	14 & 15	3 & 3	7 & 8
5	2.17	0.69	0.24	0.09	0.19	0.07	11 & 16	4 & 4	10 & 11
6	1.74	0.64	0.20	0.09	0.18	0.07	11 & 13	3 & 4	8 & 9
7	1.95	0.68	0.23	0.09	0.19	0.07	13 & 14	3 & 4	10 & 10
8	1.96	0.63	0.19	0.09	0.18	0.07	12 & 15	4 & 5	11 & 10
9	1.97	0.66	0.23	0.09	0.18	0.07	12 & 14	4 & 5	9 & 8
10	2.02	0.67	0.22	0.07	0.17	0.07	14 & 16	4 & 4	10 & 9

(1-2, from *Ulmus foliacea,* Suchumi, Georgia, U.S.S.R., 5.VI.'59, leg. A. Dzhibladze; 3-4, from *Ulmus* sp., Yougoslavia, 25.VI.'62, leg. N. Tanasijevic; 5-6, from *U. campestris,* Baranya Megye, Hungary, 5.VI.'67, leg. P. Andrasfalvy; 7-8, from *U. parvifolia,* Kuroyama, Osaka, Japan, 27.V.'66, leg. M. Sorin; 9-10, from « Akinire » (is *U. parvifolia*), Fukuoka, Japan, 19.V.'66, leg. R. van den Bosch).

Apterous viviparous female (exules).

Body about 1.55-2.40 mm long. On abd. segment I-V 1-3 pairs of very stout hairs of 0.13-0.21 mm long on very heavy sockets, mostly seemingly in tandem, with often 1-2 much thinner and shorter hairs; other dorsal hairs very inconspicuous, thorny, bent, 0.008-0.016 mm long, caudad longer; tergite VII with 8-14 hairs; tergite VIII with 2 stout hairs and about 8-16 quite small ones more laterad and ventrad. Antennae mostly of 3, sometimes 4 (especially in Japanese material), 5 or 6 segments; for interrelations of segments vide measurements; segment I with 2-4, usually 3 stout, curved hairs of about 0.065 mm and one minute hair; II with 4, rarely 3 or 5 long hairs; the rest of the antenna to the distal rim of the proximal primary rhinarium with shorter and straighter hairs, 18-28 in number; if 5 segments are present, there are 1-6 hairs on segment III. Last rostral segment short, 0.09-0.13 mm long, with 5-8 hairs besides the 3 subapical

pairs. Wax glands variable, in principle consisting of a mixture of rather uniformly large cells and uniformly small cells, but the latter type of cell in many glands lacking; spinal glands on abd. segments I-V mostly consisting of a single large cell; the pleural glands similar or consisting of several (up to five) large cells; spinal glands on tergite VII large, transversely oval, consisting of up to 18 large cells, usually without small type cells; those on tergites VI and VII much smaller; ventro-lateral glands, especially those on tergite VII and VI, usually with both types of cells. Tibiae variable, mostly very thick, e.g., 0.070 mm, with many spiny hairs of up to 0.035 mm long; hind tarsi only about 0.075 mm long. Cauda with 2 rather long hairs and 0-5 small hairs. Subanal plate with 4 long and stout hairs and some 40-80 very thin but long hairs (0.065 mm) all over its surface to the gonapophyses.

Measurements in mm.

No.	Length body	Ant.	Antennal segments			
			III	IV	V	VI
1	2.24	0.42	0.28			
2	2.27	0.38	0.26			
3	2.02	0.38	0.26			
4	2.13	0.38	0.26			
5	2.19	0.44	0.12	0.14	0.05	
6	2.07	0.37	0.24			
7	1.80	0.38	0.19	0.07		
8	2.00	0.41	0.23	0.05		
9	2.06	0.40	0.21	0.04		
10	1.73	0.35	0.18	0.05		
11	2.38	0.42	0.28			
12	2.24	0.39	0.26			
13	2.43	0.51	0.10	0.05	0.18	0.06

(1-2, from *Cynodon dactylon?,* Antona (near Massa), Toscana, Italy, 1.IX.'63, leg. D.H.R.L.; 3-5, reared on *Setaria verticillata* from *Ulmus foliacea,* Tiflis, Georgia, U.S.S.R., 4.IX.'67, leg. A. Dzhibladze; 6, reared on *Echinochloa crus galli* from *Ulmus campestris,* Erd, Hungary, 4.VIII.'67, leg. P. Andrasfalvy; 7, from *Oryza sativa,* Koego, Utsunomiya, Japan, 21.VIII.'59, leg. T. Tanaka no. 18; 8-9, from *Oryza sativa,* Ishii, Utsunomiya, Japan, 1.VII.'55, leg. T. Tanaka no. 11; 10, from grass, Osaka, Japan, 9.VIII.'59, leg. R. Takahashi; 11-13, from *Digitaria sanguinalis* var. *ciliaris,* Hirao, Osaka, Japan, 17.VII.'60, leg. M. Sorin).

Alate viviparous female (virginoparous exules and sexuparae).

Like emigrants from galls, but with very large wax glands composed of one type of cell; head with two ventral glands of about 0.035-0.040 mm diameter, composed of 4-6 cells; small, often abortive ones of 1-2 cells on vertex; spinal ones from pronotum to abd. tergite VII varying in size,

with more than 15 cells on mesonotum, often duplicated (a smaller one more laterad) on anterior abd. tergites; marginal glands on abd. tergites I-V not or indistinctly bordered, of 30-40 cells, up to 0.080 or even 0.130 mm in diameter; tergite VII with strongly transverse glands in which the cells do not touch each other in the spinal ones. Some marginal hairs on abd. segments I-VII usually thick, about 0.035-0.050 mm long, acute or blunt, bent. Antennae longer, especially segment V in comparison to VI, and with more rhinaria (fig. 24). Subanal plate with about 40 hairs besides the 4 stouter ones (fig. 51).

Measurements in mm.

No.	Length body	Ant.	Antennal segments				Rhin. on segments			
			III	IV	V	VI	III	IV	V	VI
1	2.17	0.66	0.19	0.07	0.22	0.05	11 & 13	2 & 3	11 & 12	
2	2.22	0.77	0.30	0.07	0.22	0.05	25 & 25	4 & 4	12 & 13	
3	2.24	0.78	0.30	0.09	0.22	0.05	22 & 24	5 & 5	16 & 17	
4	2.17	0.72	0.27	0.07	0.21	0.05	19 & 22	3 & 4	12 & 13	
5	2.34	0.79	0.31	0.09	0.22	0.06	27 & 29	4 & 4	14 & 15	
6	2.25	0.80	0.30	0.10	0.22	0.06	25 & 25	4 & 6	14 & 15	
7	2.13	0.85	0.35	0.10	0.22	0.06	26 & 28	6 & 4	11 & 14	1 & 1
8	2.28	0.68	0.22	0.07	0.20	0.06	13 & 14	4 & 3	11 & 13	
9	2.20	0.66	0.20	0.06	0.21	0.06	12 & 16	2 & 2	12 & 12	

(1-6, from *Cynodon dactylon?,* Antona (near Massa), Toscana, Italy, 1-12.IX.'63, leg. D.H.R.L.; 7, reared on *Setaria verticillata* from *Ulmus foliacea,* Tiflis, U.S.S.R., 4.IX.'67, leg. A. Dzhibladze; 8-9, from *Digitaria sanguinalis* var. *ciliaris,* Hirao, Osaka, Japan, 17.VII.'60, leg M. Sorin; 1-2, 8-9 pure virginoparae; 3, mixed sexupara-virginopara; 4-7 pure sexuparae).

E m b r y o taken from emigrant, or larva I (fig. 52).

Antennae of 5 segments with segments IV and V completely spinulose, segment I with 3 hairs of 0.055-0.070 mm and a tiny hair, II with 4-6 hairs, III about as long as wide, with 0-2 hairs, IV with about 20 hairs, more than twice as long as segment V; V with 2 long hairs and a primary rhinarial membrane with 3 very long (0.013 mm) and slender branches (fig. 39, 40). Last rostral segment 0.115 mm long, smooth, with 6 hairs besides the 3 subapical pairs. Abd. tergites I-VI with single pairs of rather thick marginal hairs of 0.085-0.11 mm long, and between these mostly 8 (rarely 6, or up to 10 on tergite I or II) very much thinner spinal and pleural hairs of 0.040-0.065 mm; tergite VII with in total 6 stout dorsal hairs, tergite VIII with 2 such hairs. Cauda with 2 small hairs. Subanal plate with 4 hairs of which the upper pair is the thinnest. Wax glands of the type as in apterous exuples, but mostly poorly developed and almost

invisible; head with the dorsal pair of 4-8 cells, the frontal pair smaller; spinal glands on abd. tergites VI and VII present as small transverse groups of cells; ventro-lateral glands on abd. segments I-VI consisting of a few large type cells with dorsad a cluster of small type cells, the whole gland 0.009-0.020 mm in diameter (fig. 18). Hind tarsal claws very stout, equally long, 0.080-0.100 mm long. Hind tarsi 0.06-0.07 mm long, like all other tarsi and tibiae completely smooth (fig. 4, 5).

Embryo taken from apterous exules, or larvae I (fig. 53).

Very much like the preceding, but all dorsal hairs shorter and stouter, somewhat acuminate and curved, the marginal ones rather cylindrical and then halfway their length suddenly tapering. Wax glands on head similar but those on abdomen very much better developed, also the spinal and pleural glands; in the ventro-lateral glands frequently the group of minute cells completely free from the group of large type cells and both groups about 0.013 mm in diameter (fig. 19). All other characters almost exactly as in the preceding embryos.

Discussion. Since 1947 curious *Tetraneura*'s from galls on *Ulmus* came in from various countries, sometimes identified as *T. caerulescens* Pass., *T. nigriabdominalis* Sasaki or *T. ulmi* L. It was soon noticed that the alatae contained embryos with very large hind tarsal claws. A search through available embryos in exules of *Tetraneura* showed that *T. hirsuta* Baker had embryos with similarly large hind tarsal claws, and the mentioned gall makers were identified as *T. hirsuta* Baker. This was surprising because *T. hirsuta* exules have never been reported from Europe and yet the galls on *Ulmus* were not at all rare in Southern and Central Europe.

At the occasion of a conference at Pisa, in 1963, I searched methodically for *Tetraneura*'s on grass roots, and found colonies of a species on roots of a grass tentativily identified as *Cynodon dactylon* or a perennial *Digitaria.* More specimens were reared at Bennekom on roots of *Agropyron repens, Agrostis stolonifera* and *Poa annua.* Examination showed that it was a species very much like *T. hirsuta,* but there was something wrong with the subanal plate which had more hairs than any of the *hirsuta* material at hand. A detailed study of embryos from emigrants and from exules showed that they differed consistently from embryos of *T. hirsuta.*

In following years Dr. A. Dzhibladze of Tiflis and Dr. Andrasfalvy of Budapest at my request made transfer tests with alatae from the *Ulmus* galls and sent me the product. The exules were identical with those I

found in Italy, and we then knew for certain that the gall aphids from Europe were not *T. hirsuta.* The species was thought to be undescribed.

TANAKA (1961) had made *Dryopeia hirsuta* Baker, 1921, a synonym of *Schizoneura nigriabdominalis* Sasaki, 1899, and suggested that *Tetraneura fusiformis* Mats., 1917 from Japanese *Ulmus campestris* var. *major* was the same species as *T. nigriabdominalis.* Dr. Tanaka most kindly sent Japanese material of exules of *nigriabdominalis* from roots of Rice (*Oryza sativa*) and other grasses, and to my astonishment I found both real *hirsuta* (is *nigriabdominalis*) and an aphid like our European aphid in the Japanese material.

At this stage Dr. M. Sorin was again most helpful in sending me a considerable number of *Tetraneura* galls from *Ulmus davidiana* var. *japonica* (the same as what MATSUMURA, 1917 called *Ulmus campestris* var. *major*) and from *Ulmus parvifolia.* Hairy petiolate galls from *U. davidiana* seemed to have the same inhabitants as similar, more swollen, galls from *U. parvifolia.* But when a very careful study of the embryos in the emigrants was made, there appeared to be constant differences: those from *Ulmus davidiana* had spinulose tarsi, and much longer dorsal hairs than those from *Ulmus parvifolia* which had quite smooth tarsi. I have not succeeded in finding a difference between the insect from *Ulmus parvifolia* from Japan and that from *Ulmus campestris* from Europe, neither in the adults, nor in the embryos.

In the Japanese literature one finds mention of *Tetraneura akinire* Sasaki, 1904. Dr. V. F. Eastop most kindly sent me a photocopy of Sasaki's paper and plate, and there is no doubt that the gall figured by Sasaki is the one from *Ulmus parvifolia* that I received from Dr. M. Sorin. Therefore I have adopted the name *Tetraneura akinire* Sasaki, 1904 for our aphid from « Akinire » (*Ulmus parvifolia*) and from European elms. MATSUMURA (1917) writes that he has not seen this insect or its gall. Dr. van den Bosch collected *Tetraneura* in Japan on « Akinire », and these are the same as Sorin's *Tetraneura* from *Ulmus parvifolia.* MONZEN (1929) described an aphid under the name *Tetraneura akinire* Sasaki, but from *Ulmus japonica* (= *U. davidiana* var. *japonica*). He described the gall as « spindrical » with a more pointed extremity, and as being smooth with a few short hairs. This clearly shows that he did not have the gall that I received, which is not spindle-shaped and quite evenly hairy. Monzen's gall must have been that of *T. yezoensis* Mats., 1917. On the other hand he described *T. fusiformis* Mats., 1917, with which he made successful transfers to *Echinochloa crus galli* and *Digitaria sanguinalis,* under the

name *T. yezoensis* Mats., 1917. SHINJI (1941) described *Tetraneura akinire* Sasaki (in Japanese), quoting both MATSUMURA (1917) and MONZEN (1929), but though he figures a *Tetraneura,* he seems to give pictures of a gall caused by an *Eriosoma.*

I emphasize that in the Far East *Tetraneura akinire* does not only make galls on *Ulmus parvifolia,* but also, according to specimens from Korea, on *U. davidiana* var. *japonica. Tetraneura nigriabdominalis* according to the material received seems to be restricted to the latter host species. I also emphasize that *T. akinire* is neither *Tetraneura fusiformis* Mats., 1917, nor *T. nigriabdominalis* (Sasaki, 1899), because in these the embryos have spinulose tarsi.

The description of *Schizoneura nigriabdominalis* Sasaki, 1899 from rice roots could relate to two species both living on rice roots, one of which is *T. akinire* Sasaki. But as no type material of Sasaki is left, there is no objection against following TANAKA (1961) who substituted the name *T. nigriabdominalis* (Sasaki) for his *T. hirsuta* (Baker).

It is amazing that the aphid here described has not been recorded before under any name from its primary or secondary host plants in Europe, though it is not at all rare in this continent. In Japan it has repeatedly been collected on Gramineae. Dr. Takahashi sent me a slide identified as *Tetraneura fusiformis* Mats.?, and Dr. Tanaka several slides identified as *T. nigriabdominalis* Sasaki. Also Dr. Sorin sent very good material from grass roots, as well as Dr. W. H. Paik, Suwon, Korea.

According to the hairs drawn on the subanal plate, NEVSKY's (1929) fig. 99 of *T. hirsuta* Baker might represent *T. akinire,* but the chaetotaxy of the rest of the body and antennae does not occur in any *Tetraneura* that I know. Nevsky records it from *Panicum crus galli* and *Setaria viridis,* two probable hosts of *akinire,* from Tashkent (Usbekistan) and Phrynze (Kirgistan).

T y p e s. As far as known Sasaki left no type material of this aphid. In view of the difficult identity problem I have chosen a neotype and neoparatypes. Holoneotype: Alate viviparous female, from hairy, spindle-shaped gall no. 502 on *Ulmus parvifolia,* Kuroyama (Osaka), Japan, 27. V.'66, leg. M. Sorin. Neoparatypes: fundatrix, alate emigrants, and embryos with collecting data as for holoneotype, and from similar galls with the same collecting data but numbered 500, 501, 503, 504, 505, 506 and 507. in the author's collection.

Tetraneura (Tetraneurella) basui spec. nov.

Apterous viviparous female (exul).

Body about 1.5 mm long. Thoracic and abdominal segments with one or 2 pairs of stout, long marginal hairs, on tergites I and II the longest (about 0.17 mm) gradually shorter cephalad and caudad; besides this 2-4 much shorter (0.030-0.075) but equally stiff hairs marginally on each side; spinal and pleural hairs on abd. tergites I-V quite numerous, 20-30 per tergite, 0.040-0.130 mm long, stout, usually just blunt at apex. Antennae (fig. 46) in available specimens of 5 segments; segment I with 2 stout hairs, II with 2 or 3 hairs, III without hairs, IV with 4 erect, very stout hairs of about 0.045 mm long. Last rostral segment about 0.11 mm long, with 6-8 hairs besides the 3 subapical pairs. Ventro-lateral wax glands roundish (fig. 16), on abd. segment I and III 0.020-0.035 mm in diameter, composed of cells in two sizes: 2-8 scattered larger cells which typically do not touch each other, and a number of very small cells that fill up the spaces left by the larger cells; small (0.010-0.015 mm diameter) spinal glands of similar composition erratically present; pleural, seemingly marginal, glands (fig. 17), consisting of a single or two or three touching, larger, strongly rimmed, cells of 0.010-0.015 mm diameter, rather regularly present. Legs not very thick (hind femora to about 0.09 mm, hind tibiae to about 0.055 mm halfway their length) with few stout erect hairs of up to about 0.040-0.045 mm long; hind tarsal joint about 0.09 mm long. Tergite VIII with 2 stout spinal hairs and 4-6 much smaller more lateral hairs. Cauda with 2 hairs. Subanal plate with 4 long hairs and 5-8 somewhat shorter hairs besides those on the rudimentary gonaphyses.

Measurements in mm.

No.	Length body	Ant.	Antennal segments		
			III	IV	V
1	1.53	0.36	0.09	0.11	0.07
2	1.49	0.36	0.08	0.10	0.07
3	1.82	0.35	0.08	0.10	0.06
4	1.84	0.36	0.08	0.10	0.07

(1-4, from roots of Gramineae, Kalimpong [W. Bengal], India, 7.III.'58, leg. A. N. Basu no. 176[4]).

Embryos taken from apterous exules.

Antennae of 5 segments with segments II, III, IV and V very spinulose. Segment I with 2 (- 3) stout hairs of 0.045 mm long and one minute hair of 0.004 mm; segment III with 2 stout hairs of 0.065 mm long; segment IV with 4 stout hairs, the longest 0.060 mm, the shortest 0.045 mm long. Last rostral segment 0.100 mm long, with 8 stout hairs besides the 3 subapical pairs. Dorsum with remarkably stout hairs; tergites I-V with single pairs of marginal, pleural and spinal hairs; spinal and marginal hairs at base about 0.004-0.005 mm thick, 0.120-0.150 mm long, slightly blunt; pleural hairs less than half as thick, only 0.035-0.060 mm long; tergite VII-VIII only with spinal and marginal hairs. Cauda with 2 hairs. Subanal plate with 4 stout hairs. Wax glands only ventrolaterally visible, consisting of a very indistinct, rimless, group of 2-5 roundish cells. Hind tarsal claws strongly asymmetrical, the longest 0.067 mm, the shorter one 0.050 mm long. Tarsi and the whole tibiae markedly spinulose, the latter with stout, dorsally blunt, hairs of about 0.050 mm long.

Discussion. Apterous exules and embryos can very easily be recognized by the 4 long and stout hairs on the penultimate antennal segment and the long and very stout hairs on all abdominal tergites. The asymmetry of the claws in embryos resembles that in *Tetraneura javensis* v.d. Goot, but that species has a totally different chaetotaxy. All the long dorsal hairs in embryos are somewhat acuminate or bluntish. Perhaps one may predict that embryos in emigrants from *Ulmus* galls will show even longer but finer hairs.

Types. Holotype: Apterous viviparous female (no. 3 of measurements), from roots of grass, Kalimpong (West Bengal), India, 7.III.'58, leg. A. N. Basu no. 176(4). Paratypes: Apterous viviparous females with data as for holotype. Two embryos taken from the holotype are also marked holotype.

Tetraneura caerulescens (Passerini, 1856)

1856. Passerini, G., Giornale I Giardini, 3 : 262, *Pemphigus caerulescens.*
1880. Lichtenstein, J., Feuilles Jeunes Naturalistes, 10 : 125, *Tetraneura rubra.*
1923. Theobald, F. V., Bull. Soc. R. Ent. Egypte, 15 : 70-73, *Tetraneura aegyptiaca.*

Fundatrix.

Body nearly globular, about 1.55-2.00 mm long, without wax glands, on abd. segments I-V with single or double, thin marginal hairs of about 0.040-0.065 mm, single pairs of spinal hairs of about 0.030-0.045 mm and

erratically pleural hairs of 0.026-0.045 mm; tergite VII with 4-6 hairs; tergite VIII usually with 2, sometimes with 4 hairs. Antennae at least of 4 segments, but then always segment III with a membraneous part like a subdivision. Last rostral segment short, 0.09-0.10 mm, with convex sides and 4 hairs besides the 3 subapical pairs.

Measurements in mm.

No.	Length body	Ant.	Ant. segments	
			III	IV
1	1.62	0.26	0.11	0.06
2	1.62	0.26	0.11	0.06
3	1.94	0.29	0.12	0.07
4	1.93	0.28	0.12	0.07

(1-2, *Ulmus campestris*, Antibes, France, 1.IV.'62, leg. R. v.d. Bosch; 3-4, *U. campestris*, Karaj, Iran, 21.V.'68, leg. R. v.d. Bosch).

Alate viviparous female (emigrants from gall).

Body about 1.65-2.25 mm long. Head capsule with about 24-30 hairs of about 0.020-0.035 mm long, sometimes with traces of wax glands on vertex. Antennae (fig. 26) 1/3 - 2/5 of length of body, with segment VI and most of segment V slightly spinulose; segment I with 3 hairs; segment II with 3 hairs of about 0.022 mm long; segment III with 11-21 rhinaria, of which several may be short, but most encircle about 4/7 of the segment, often partly joined to very abnormal shapes; segment IV with 2-4 rhinaria; segment V with 3-6 rhinaria of which the terminal one may be fused with the primary one; segment VI elongated and not much different in length from V, with a very irregular star-shaped primary rhinarium. Last rostral segment about 0.085-0.11 mm long, with 5-7 hairs, besides the 3 subapical pairs, about 7/12 of 2nd joint of hind tarsi. Sometimes traces of wax glands on mesonotum, but not on abdomen. Legs rather long; dorsal hairs half way hind tibiae not adpressed, 0.020-0.030 mm long. Wings with the conspicuously pale stigma bordered with black. Siphunculi absent. Abdominal tergite VIII with 2 hairs of about 0.065-0.080 mm and 2-6 shorter hairs more laterad. Cauda with 2 hairs. Subanal plate usually with 4, but not infrequently with 5, rarely 6, long hairs besides those on the gonapophyses.

Measurements in mm.

No.	Length body	Ant.	Antennal segments				Rhin. on segments		
			III	IV	V	VI	III	IV	V
1	1.66	0.64	0.21	0.09	0.11	0.13	13 & 21	3 & 4	5 & 4
2	1.77	0.64	0.23	0.09	0.11	0.11	14 & 18	4 & 3	3 & 4
3	2.19	0.72	0.26	0.09	0.14	0.13	17 & 18	3 & 2	5 & 5
4	2.11	0.73	0.22	0.10	0.15	0.13	13 & 14	4 & 3	4 & 5
5	1.94	0.66	0.21	0.09	0.14	0.12	13 & 15	4 & 4	4 & 4
6	1.89	0.62	0.20	0.09	0.13	0.11	13 & 13	2 & 3	5 & 5

(1-2, from *Ulmus campestris,* Antibes, France, 1.VI.'62, leg. R. v.d. Bosch; 3-4, from *U. campestris,* Karaj, Iran, 21.V.'68, leg. R. v.d. Bosch; 5-6, from *U. campestris,* Szederkeny, Hungary, 5.VI.'67, leg. P. Andrasfalvy).

Apterous viviparous female (exules).

Body about 1.50-2.20 mm long. All dorsal hairs rather long and fine, not sharply bent near base but often curved on distal half, in single transverse rows, spinally and pleurally 0.030-0.070 mm long; a single pair of the several marginal hairs from pronotum to abd. tergite VII gradually longer and stouter, to 0.150 mm. Antennae of 5 segments, in available specimens with typically all segments of the flagellum about equal in length, 1/6 - 1/5 of length of body; segment I with 2-3 hairs of 0.016-0.026 mm long, II with 2, rarely 3 hairs, III without hairs, IV with 4-6 erect hairs. Last rostral segment 0.11-0.13 mm long, with normally 6, sometimes 4-8 hairs besides the 3 subapical pairs. All wax glands very well developed, consisting of a round or oval cell of 0.016-0.030 mm diameter, surrounded by a thick (0.013 to 0.021) closed ring of cells that mostly have their long axis at right angles to the central cell; ventrolateral glands on abdomen (fig. 11, 12) with 2-4 fused central cells resulting in a very irregular long central one, which sometimes, on tergite VII, may be subdivided. Tibiae rather thin, 0.040 mm in the middle; hind tarsi about 0.085 mm long. Tergite VIII with 2 hairs. Cauda with 2 hairs. Subanal plate typically with 4 long hairs besides those on the gonapophyses.

Measurements in mm.

No	Length body	Ant.	Antennal segments		
			III	IV	V
1	1.84	0.33	0.07	0.07	0.09
2	1.87	0.32	0.07	0.07	0.09
3	2.00	0.34	0.09	0.07	0.09
4	1.81	0.36	0.09	0.09	0.09
5	1.53	0.31	0.06	0.07	0.09

(1-3, reared at Bennekom, on *Poa annua,* from emigrants no. 1-2 from Antibes, France, 21.VI.-2.VII.'62, leg. R. v.d. Bosch; 4-5, from *Cynodon dactylon,* Karaj, Iran, 19. VIII.'55, leg. G. Remaudière no. i 1065).

Alate viviparous female (virginoparous exules and sexuparae).

Recently redescribed (HILLE RIS LAMBERS, 1967). In general like emigrants from galls, but with the wax glands of apterous exules. Large glands on head ventrad of the median ocellus, 2 smaller pairs more dorsad. Antennal segment III with 10-18 rhinaria; segment IV comparatively much shorter, to less than half as long as segment V. Wings similar. Ventro-lateral wax glands on tergite VII often with 2 separate central cells, therefore elongated 8-shaped.

Embryo taken from emigrant.

Antennae (fig. 41) of 5 segments with segment IV and V completely spinulose, segment I with 2 long hairs of 0.050 mm and a short one, II with 2 long hairs, III short and thin, without hairs, IV with 4 long hairs; base of V with 2 long hairs and one short one of 0.016-0.020 mm; primary rhinarium on V with 2 horns. Last rostral segment 0.10-0.11 mm long, with 6 hairs besides the 3 subapical pairs. Abd. tergites I-V with one pair of marginal hairs of 0.070-0.085 mm long, one pair of spinal hairs of 0.045-0.050 mm, and one pair of pleural hairs of the same length; tergites VI and VII and often also V without pleural hairs; tergite VIII with 2 hairs. Cauda with 2 hairs. Subanal plate with 4 long hairs. Wax glands as in exules, all very well developed, the ventro-lateral glands typically with 2 central cells that may touch or not; in general in the spinal and pleural gland diameter of the central cell not more than half the diameter of the gland. Hind tarsal claws 0.030 mm long. Tarsi and distal ¼-½ of tibiae markedly spinulose (fig. 3).

Embryos taken from exules, or larvae I (fig. 54).

As in preceding embryos.

Discussion. This is in all adults and embryos one of the easiest recognizable species, by its long last ant. segment, few antennal hairs, short last rostral segment, the 4 long hairs on the subanal plate (first mentioned by Eastop), wax glands, pterostigma, etc. Passerini's original specimens still exist and were mounted by Dr. H.L.G. Stroyan and the author. *T. rubra* Lichtenstein, and *T. aegyptiaca* Theobald are synonyms.

The species is distinctly southern, and exules have not been found in the Netherlands or England. I have seen specimens from galls on *Ulmus* from Southern France, Italy, Switzerland, Austria, Hungary, Yougo-

slavia and Iran. BÖRNER (1952) records it from Southern Germany, MORDVILKO (1935) from Southern Russia, THEOBALD (1922) as *T. aegyptiaca* from Egypt. It is not known from America or from more Eastern countries than Iran. MATSUMURA (1917) writes that G. Horvath identified specimens that he sent him from Japan as *T. rubra* Lichtenstein but I strongly doubt that identification.

The name is often spelled as *T. coerulescens* but I apply, like EASTOP (1966), the original spelling by PASSERINI (1856).

Types. Lectocotypes: alate sexuparae (from roots of *Eragrostis megastachyae,* October, no locality) in the Passerini collection in the Zool. Institute, Parma, Italy, and in the collections of Dr. H. L. G. Stroyan, Harpenden, England and of the author. Types of *T. rubra* Lichtenstein possibly in the Hungarian Nat. Museum, Budapest; those of *T. aegyptiaca* Theobald in Brit. Mus. (Nat. Hist.), London.

Tetraneura (Tetraneurella) javensis van der Goot, 1917

1917. Van der Goot, P., Contrib. Faune Ind. Néérland., 1 (3) : 260-263, *Tetraneura javensis.*
1927. George, C. J., Jl. Asiat. Soc. Bengal (N.S.), 23 : 9, *Tetraneura cynodontis* subspec. *coimbatorensis.*

Alate viviparous female (emigrants from gall).

Body about 1.80-2.00 mm long. Head capsule with about 28-32 hairs of 0.016-0.040 mm long, and with two large (0.030 mm diameter) strongly rimmed, indistinctly facetted wax glands ventrad of the median ocellus. Antennae (fig. 27) rather short, less than 1/3 length of body, with only distal 1/5 part of segment V and segment VI spinulose; segment I with 5-7 hairs; segment II with 7 hairs; segment III thick, between the rhinaria to 4 times as thick as at base, with 11-14 partly very wavy, short (¼ circumference) to long (4/7 circumference) rhinaria; segment IV oval, not much thinner than III, with 3-5 similar rhinaria; segment V thinner than IV, with 4-7 rhinaria; sometimes rhinaria have little « islands » on the membrane; segment VI may be almost completely fused with V, or quite free and then much thinner than V; processus terminalis about half as long as the segment. Last rostral segment about 0.080 mm long, with 5-6 hairs besides the 3 subapical pairs, half as long as 2nd joint of hind tarsi. Wax glands on thorax and abdomen not discernible, possibly absent on abdomen. Legs rather short; hind tibiae rather distinctly thinnest in the middle, and dorsal hairs there about 0.020-0.022 mm long. Siphunculi apparently absent. Abd. tergite VIII with 8-10 hairs. Cauda with 4 hairs.

Measurements in mm.

No.	Length body	Ant.	Antennal segments				Rhin. on segments		
			III	IV	V	VI	III	IV	V
1	2.09	0.61	0.20	0.07	0.16	0.05	12 & 12	5 & 3	6 & 4
2	1.96	0.58	0.19	0.06	0.16	0.05	11 & 12	3 & 4	6 & 6
3	1.84	0.61	0.21	0.06	0.15	0.06	11 & 12	4 & 4	5 & 5
4	?	0.65	0.21	0.07	0.17	0.07	12 & 14	3 & 3	7 & 6

(1-4, from gall on *Ulmus wallichiana,* Murree, West Pakistan, 6.VI.'67, M. A. Ghani no. 894).

Apterous viviparous female (exules).

Body 1.50-2.50 mm long. Thoracic and abdominal segments marginally each with 2-3 pairs of stout, long (0.085-0.17 mm), on distal half somewhat dark bristles and some shorter hairs; tergite VIII with 6 hairs; spinal and pleural hairs on other tergites about 0.052 mm. Antennae of 4 or 5, probably sometimes of 3 segments, segment I with 5-6 stout hairs and one minute hair, II with 6-9, part between II and terminal segment with 20-28 hairs; if 5 segments present, segment IV with 20-25 hairs; hairs on flagellum up to about 0.036-0.048 mm long. Last rostral segment about 0.105-0.120 mm long, with 6-8 hairs besides the subapical 3 pairs. Ventro-lateral wax glands only rarely like fig. 51 I in VAN DER GOOT (1917) and such a gland apparently only on mesonotum; other ventro-lateral glands (fig. 13-15) nearly always with the large cell touching the periphery of the gland; number of small cells in the ventro-lateral glands varying from about 20-40, highest on the mesothorax, lowest on abd. tergite VI or VII; spinal and pleural glands as figured by Van der Goot, but especially the pleural glands often only consisting of a large cell, and always the small cells smaller than in the ventro-lateral gands. Legs not very thick (hind femora to about 0.10 mm, hind tibiae to about 0.060 mm halfway their length); hind tarsal point about 0.095 mm long. Tergite VIII with 6, more rarely 8 hairs. Cauda with 4 hairs. Subanal plate with 10-14 about equally long hairs besides those on the rudimentary gonapophyses.

According to Van der Goot and George body in life whitish to yellowish white.

Measurements in mm.

No.	Length body	Ant.	Antennal segments		
			III	IV	V
1	1.72	0.35	0.17	0.06	
2	1.62	0.34	0.17	0.05	
3	1.88	0.38	0.21	0.05	
4	1.92	0.41	0.11	0.14	0.06

(All from *Saccharum officinarum;* 1-2, Naruti, India, 10.IV.'34, leg. L. Ghosh; 3-4, Coimbatore, India, 10.I.'57,, leg. S. K. David).

E m b r y o s taken from apterous exules.

Antennae probably of 4 segments, with stout, pointed hairs of 0.035-0.045 mm long; segment I with 7 hairs (and one minute hair), II with 10 hairs, III with 23 hairs; primary rhinarium on ultimate segment with 4 long horns. Each of abd. segments I-V with marginal hair groups consisting of 1 long (0.070-0.090 mm) hair and 3-5 shorter (0.025-0.035 mm) and thinner hairs gradually passing into the 14-16 spinal and pleural hairs present that are similar in length to the shorter marginal hairs; tergite VII with 12 long and shorter hairs; cauda with 4 hairs. Only ventro-lateral wax glands visible, consisting of a large (0.010-0.017 mm diameter) oval cell with on one or two opposite sides almost equally large groups of very small cells partly half encircling the large cell. Hind tarsal claws mutually different in size, the largest claw 0.070-0.075 mm long, the smaller claw 0.050-0.055 mm long; this asymmetry seems to be specific. Tarsi distinctly spinulose.

E m b r y o taken from spring migrant.

Antennae with chaetotaxy as in other embryos, but hairs slightly longer (to 0.050 mm); primary rhinaria on ultimate segment 4-horned (fig. 49). Hairs on abd. segments I-V more numerous, about 24-32 dorsal hairs per segment, the marginal group of 5-7 hairs with the long hairs rather variable, 0.045-0.070 mm long. Ventro-lateral wax glands different, mostly with only a distinct large cell and a few scattered minute cells, but more caudad sometimes with rather distinct clusters of small cells. Hind tarsal claws strongly different, the longer one 0.065 mm, the shorter one 0.045 mm long. Tarsi spinulose (fig. 2).

Discussion. VAN DER GOOT's (1917) description of apterous exules could apply to several species, but his figures of the wax glands exclude doubt about the identity of his aphid. MORDVILKO (1930, 1935) lists *T. javensis* as a synonym of *T. ulmi* L. TAKAHASHI (1921, 1923) records *T. javensis* from Formosa, but in 1931 he writes that his Formosa records relate to *T. hirsuta* Baker. GEORGE (1924) lists *T. javensis* as a synonym of *T. ulmi,* describes *T. javensis* as *Tetraneura* sp. from Sugar-cane, and later (1927) describes it as *T. cynodontis coimbatorensis* subspec. nov. EASTOP (1966) was the first to reinstate the name *T. javensis* v.d. Goot in his key to apterous exules of *Tetraneura.*

This aphid has only been recorded from *Saccharum officinarum,* Sugar cane, from Pakistan (EASTOP), India and Java. Alatae were described by GEORGE (1927) but not so that they could be recognized from that description. Neither Dr. Eastop nor I have seen alatae from secondary hosts.

I venture to describe emigrant alatae from a gall on *Ulmus wallichiana* as *T. javensis* because of the very great similarity of the embryos in these emigrants with those from apterous exules. One is immediately struck by the two claws of a hind tarsus being greatly different in length, the 4-branched membrane of the ultimate primary rhinaria, the similar chaetotaxy of abdominal tergites I-V and VII and the cauda and antennae. Only the wax glands seem to be slightly different, although wax glands similar to those in embryos from exules are sometimes found in embryos from emigrants. Unfortunately no data are available on the type of gall on *Ulmus wallichiana* from which the described emigrants were collected.

The primary host plant is given here as *Ulmus wallichiana,* the name used by the collector, Dr. M. A. Ghani. I find, however, that the name should be *U. wallichii,* and that *U. brandisiana* often goes under the name *U. wallichiana* (or *wallichii*).

Types. No material of *Tetraneura javensis* was found among the slides left by Dr. van der Goot.

Tetraneura (Tetraneurella) nigriabdominalis (Sasaki, 1899)

1899. Sasaki, C., Handbook of insect pests of crops in Japan (in Japanese): 435, *Schizoneura nigriabdominalis.*
1917. Matsumura, S., A collection of essays for Mr. Yasushi Nawa, 3 : 74-75, *Tetraneura fusiformis.*
1921. Baker, A. C., Monthly Bull. California Dept. Agric., 10 : 159-160, *Dryopeia hirsuta.*
1923. Van der Goot, P. in van Heurn, Meded. Inst. Plantenziekten Batavia, 61 : 41-42, *Tetraneura oryzae.*
?1924. Mordvilko, A. K., Eriosoma lanigerum and other Eriosomea (in Russian, not seen), *Tetraneura chinensis.*

Fundatrix.

Body almost globular, about 1.50 mm long, without wax glands, on abd. tergites I-V with single pairs of long marginal hairs of about 0.14 mm long, with very few, perhaps 4-6 spinal and pleural hairs of about 0.045 mm long; tergite VII with 4 long hairs, tergite VIII with 2 hairs like the marginal ones. Antennae of 3 segments without a trace of subdivision of segment III. Last rostral segment about 0.095 mm long, with 4 hairs besides the 3 subapical pairs. Cauda with 2 hairs, subanal plate with 4 hairs.

Measurements in mm.

No.	Length body	Ant.	Ant. segments
			III
1	1.55	0.21	0.14
2	1.47	0.22	0.13

(1, with emigrants no. 5-6, gall no. 520; 2, with emigrants no. 7, gall no. 521).

Alate viviparous female (emigrant).

Body about 1.70-2.25 mm long. Head capsule with about 28-32 hairs of 0.030-0.042 mm long, without wax glands. Antennae (fig. 28) about 1/3 of length of body, with segment VI and distal 1/2-4/7 part of V spinulose; segment I with 3-4 hairs; segment II with 3-6 hairs; segment III with 9-12 hairs of 0.010-0.015 mm long and 12-18 rhinaria; segment IV with 2-4 hairs, and 3-5, rarely 6, rhinaria; segment V with 9-15 hairs and 6-12 rhinaria. Last rostral segment 0.090-0.105 mm long, with 5-6 hairs besides the 3 subapical pairs, about 5/8 of second joint of hind tarsi. Dorsal hairs hard to examine because of embryos; marginal hairs on abd. segment I-V probably in single pairs, about 0.045-0.055 mm long, with fine apices; tergite VII with 2 spinal hairs of about 0.060 mm long and laterad of these 2-4 smaller hairs. Wax glands not detectable, probably absent. Siphunculi absent. Cauda with 2, or rarely 3 hairs. Subanal plate with 4 stout hairs and 6-12 often only slightly smaller hairs besides those on the gonapophyses.

Measurements in mm.

No.	Length body	Ant.	Antennal segments				Rhin. on segments		
			III	IV	V	VI	III	IV	V
1	1.95	0.64	0.22	0.09	0.18	0.07	12 & 14	5 & 3	10 & 11
2	1.86	0.58	0.20	0.07	0.15	0.06	13 & 14	4 & 5	10 & 8
3	1.74	0.58	0.20	0.07	0.16	0.06	13 & 14	3 & 4	6 & 8
4	1.80	0.62	0.20	0.07	0.17	0.07	12 & 14	4 & 4	8 & 7
5	2.22	0.72	0.25	0.09	0.20	0.07	14 & 15	4 & 3	14 & 10
6	2.23	0.69	0.22	0.09	0.19	0.08	14 & 14	5 & 6	9 & 10
7	2.17	0.66	0.22	0.07	0.19	0.07	15 & 16	5 & 3	10 & 12
8	2.12	0.72	0.25	0.10	0.19	0.09	15 & 18	5 & 4	10 & 11

(All from *Ulmus davidiana* var. *japonica,* Sapporo, Hokkaido, Japan, 4.VII.'66, leg. M. Sorin; 1-2, from gall 510; 3-4, gall 519; 5-6, gall 520; 7, gall 521; 8, gall 523).

Apterous viviparous female (exules from Japan).

Body about 1.80-2.15 mm long, more elongated than in other species. On each of abd. segments I-V marginally in tandem 2 pairs of very stout hairs of 0.17-0.26 mm long; between the longitudinal row of these hairs and the line connecting the stigmal pori, 0-2 rather similar, smaller, hairs; all these hairs, and also the longer hairs on the corresponding sternites have a tendency to have an exceedingly small swelling just below the more or less rounded, thin, tip; spinal and pleural hairs very short, 0.004-0.015 mm long, strongly curved, subacute, placed on a very small brownish yellow ring, not numerous. Tergite VII with shorter marginal hairs and between those with 4-6, mostly 6, hairs of quite variable shape and position; they may be like dorsal hairs on more anterior tergites, or stout and bent and up to 0.050 mm long, or both on the same specimen; tergite VIII with 2 stout and long (e.g. 0.17 mm) curved spinal hairs, in one specimen with one more smaller hair. Antennae of 3, 4 or 5 segments, but the segmentation always incomplete and therefore the flagellum rigid; segment I with 3-4 very stout, usually hooked or twisted hairs of about 0.070 mm and one very small hair of 0.009 mm long; segment II with 3-4 very stout hairs; segment III, if recognizable, with 0-2 small hairs; segment IV if only 3 or 4 segments are present with the basal part hairless, in 5-segmented antennae with 15-22, rarely 13 nearly straight hairs of about 0.035-0.045 mm long, subacute, not with fine apices; the 2-3 hairs on basal part of last segment about 0.016 mm long. Last rostral segment thick, about 0.11-0.13 mm long, with 2 pairs, rarely 1½ pair of lateral hairs and one pair of dorsal hairs besides the 3 subapical pairs. Wax glands variable, in principle consisting of a mixture of several large cells and

several very small cells, but often the small cells in small glands wanting; ventro-lateral glands oval or round, 0.025-0.050 mm in diameter, composed of 3-8 large cells and one or two clusters of minute cells, mostly dorsad, squeezed between the large cells and the strong rim of the gland; spinal and pleural glands mostly consisting of 1 large cell, but sometimes of up to 4 cells, without minute cells; spinal glands on tergite VII transversely oval, consisting of 7-18 large cells, apparently never with minute cells. Tibiae thickest in the middle, to 0.065 mm, with many long (0.035-0.048 mm) and stiff hairs, the dorsal ones mainly bluntish; hind tarsi about 0.075-0.090 mm long. Cauda with 2 hairs and rarely a small additional hair. Subanal plate with 24-45 thin hairs of about 0.035-0.043 mm long besides the 4 very stout curved hairs of 0.11 mm long and the hairs on the gonapophyses.

Measurements in mm.

No.	Length body	Ant.	Antennal segments		
			III	IV	V
1	2.03	0.38	0.07	0.15	0.05
2	2.09	0.40	0.07	0.15	0.05
3	2.00	0.40	0.22	0.05	
4	2.04	0.39	0.07	0.15	0.05
5	1.85	0.38	0.07	0.19	
6	1.99	0.43	0.28		

(All from roots of *Oryza sativa,* Japan; 1-2, Mamada, 6.IX.'59, leg. M. Inaizumi, Tanaka slides 13 and 15; 3-4, Utsunomiya, 17.IX.'57, leg. T. Tanaka; 5-6, Okamoto, 5.VI.'59, leg. S. Asand, Tanaka slide no. 17).

Alate viviparous female (sexuparae from Japan).

Body about 1.90-2.45 mm long. Head capsule with about 24-28 hairs of which the stoutest, on front, are sharply bent inwards and 0.035-0.040 mm long, the shortest 0.013-0.016 mm long; 2 ventral wax glands 0.021-0.035 mm in diameter, 2 frontal ones mostly developed, about 0.016 mm, those on vertex absent or vestigial. Antennae (fig. 29) 1/3-3/8 of length of body, with segment VI and distal ½-¾ of V spinulose; segment I with 3-4 hairs; segment II with 3-5 hairs, segment III with 14-22 rhinaria and 5-7 hairs; segment IV with 3-5 rhinaria and 2-3 hairs; segment V with 10-14 rhinaria and 6-8 hairs. Last rostral segment 0.100-0.120 mm long, with 4-6 hairs besides the 3 subapical pairs, about 5/6 of 2nd joint of hind tarsi. Some marginal hairs rather stout and acuminate, on anterior tergites to 0.040 mm long, curved or sharply bent in contrast to the thin spinal ones of about 0.016 mm long; tergite VII with 4 (-6?) hairs

besides the marginal ones; tergite VIII with 2 stout hairs of about 0.075 mm. Wax glands on body distinct spinally on mesonotum and metanotum (about 25 cells per gland), but very indistinct though quite large on abdomen; spinal glands on tergite I about 0.045 mm in diameter with some 25 cells, but caudad rapidly decreasing in size till they vanish on tergite IV or even III, to reappear on tergite VII or sometimes VI; pleural glands very small or absent; marginal glands large, 0.060-0.085 mm in diameter, present from segment I-VII. Dorsal hairs halfway hind tibia 0.016-0.020 mm long, rather adpressed. Cauda with 2, more rarely 3, hairs. Subanal plate with about 18-28 hairs of about 0.022 mm long, and 2 much stouter ones of about 0.045 mm, besides those on the gonapophyses.

Measurements in mm.

No.	Length body	Ant.	Antennal segments				Rhin. on segments		
			III	IV	V	VI	III	IV	V
1	1.95	0.75	0.27	0.09	0.21	0.06	19 & 20	4 & 4	14 & 13
2	2.01	0.72	0.25	0.09	0.21	0.06	17 & 18	5 & 4	11 & 11
3	2.09	0.71	0.27	0.07	0.19	0.06	18 & 21	3 & 4	12 & 12
4	2.34	0.69	0.26	0.08	0.19	0.05	17 & 19	5 & 5	14 & 14
5	1.93	0.63	0.23	0.07	0.18	0.05	15 & 19	5 & 3	12 & 10
6	2.14	0.70	0.26	0.07	0.20	0.05	15 & 18	5 & 4	13 & 13

(All from *Oryza sativa,* Utsunomiya, Japan; 1-2, 17.IX.'57, leg. T. Tanaka; 3-6, 23.IX.'56, leg. T. Tanaka no. 151).

First instar larva of fundatrix (from cast skin) (fig. 47a-c).

Black and heavily sclerotized, with the segmental borders membranous and pale, quite smooth. All appendages black, smooth. Hairs on dorsum all with a smaller or larger globular knob at apex, but these knobs apparently hollow and often caving in at the top which results in an enlarged, triangular apex. Dorsal hairs on abd. tergites I-V in 6 rows; marginal hairs 0.050 mm, spinal and pleural hairs much thinner, 0.022 mm long. Antennae vide figure 47 b. Last rostral segment very slender, 0.150 mm long, with 4-6 fine hairs besides the 3 subapical pairs. Tibial hairs especially on hind tibiae very long, with just incrassate apices; hind tarsal claws 0.060 mm long, shorter than the joint (0.070 mm). No wax glands present.

Embryos taken from emigrant.

Antennae of 5 segments, with segment IV-V distinctly spinulose; segment I with 3 hairs of about 0.060 mm and one small hair of 0.008-

0.010 mm long; segment II with 2-3 long hairs; segment III with 0-1 hair; segment IV with 13-17 hairs of about 0.065-0.075 mm long; primary rhinarium on segment V with 3-branched membrane. Last rostral segment about 0.110-0.118 mm long, with normally 6 hairs besides the 3 subapical pairs. Abd. tergites I-V with single pairs of marginal hairs of about 0.100-0.110 mm long and 6 considerably thinner pleural and spinal hairs of 0.080-0.090 mm long; tergite VII with 4, rarely 3, spinal and pleural hairs of 0.100 mm long besides 2 marginal hairs; tergite VIII with only 2 hairs which are thicker than all others; all these hairs with very fine apical parts. Cauda with 2 hairs. Subanal plate with 2 pairs of hairs of which the lowest are thickest. Wax glands not distinct, with two types of cells but the small cell type so very small that they are only on an occasional gland distinctly visible in the outer margin of the gland; head with ventral glands 0.025-0.030 mm in diameter, of 7-9 cells of the large type, rarely with 1-2 small type cells, and with frontal glands of 2-4 cells; ventro-lateral glands on abd. segments I-V of 5-9 large type cells much smaller than those on ventral side of head and sometimes with up to 7 minute cells around the large type cell group; spinal glands, consisting of a transverse group of small large type cells, apparently only present on tergite VII. Hind tarsal claws 0.065-0.078 mm long. Hind tarsi mostly only very slightly spinulose, hind tibiae smooth, but fore and middle tarsi much more distinctly spinulose, like the apices of the fore and middle tibiae.

E m b r y o s taken from apterous exules (from Japan).

Antennae of 5 segments with segment IV, V, and sometimes III, spinulose; segment I with 3 stout, more or less acuminate hairs of about 0.040-0.050 mm long and one minute hair; II with 4 such hairs; III apparently without hairs; IV with 14-19 rather straight and fine hairs of about 0.045 mm long; primary rhinarium on V with 3-branched membrane. Last rostral segment with very few spinules, about 0.105 mm long, with 2 marginal pairs of hairs and 2 dorsal hairs besides the 3 pairs near apex. Complete dorsal setal pattern: head: 8; pronotum: 4 laterally, 4 spino-pleurally; mesonotum: 4 laterally, 6 spino-pleurally; metanotum: 4 laterally, 6 spino-pleurally; abdominal tergites I-VI: 2 laterally, 6 spino-pleurally; tergite VII: 2 laterally, 4 spino-pleurally; VIII: 2 spinally; cauda: 2 hairs; all these hairs stout, curved, more or less acuminate, rarely with incrassate, rounded apices. Marginal hairs thicker and on abd. segments I-V 0.055-0.080 mm long, spino-pleural hairs 0.030-0.045 mm

long. Subanal plate with 4 hairs. Wax glands with 2 types of cells; ventral glands on head of 5-7 large cells; spinal ones on pronotum of 8-10 large cells; spinal glands on tergite VII of 8-12 large cells, on other tergites absent or too small to find; ventro-lateral glands rather large, consisting of a few, 2-7, large type cells with dorsad a cluster of minute cells, the whole gland up to 0.021 mm wide and 0.030 mm long. Hind tarsal claws stout, equally long, 0.070-0.087 mm long. Tarsi and about distal 1/4-1/3 part of tibiae spinulose.

Embryos taken from alate viviparous exules (from India).

Setal pattern as in preceding embryos, but on abd. segments I-V dorsal hairs with very fine apices, marginal hairs about 0.105-0.110 mm long, spinal and pleural hairs 0.052-0.067 mm long; this is easily overlooked because the hairs have a basal portion as long as the corresponding hairs in the preceding embryo with a refractive index different from the thin distal portion.

Discussion. A study of specimens identified by various workers as *Tetraneura fusiformis* Mats., *T. hirsuta* (Baker), or *T. nigriabdominalis* (Sasaki) shows that the material agrees in that the embryos have enlarged hind tarsal claws, single marginal hairs, spinulose tarsi, and similar wax glands. But examination of more details indicates that the material thus separated is far from homogeneous, and can be split into four groups:

I. Material from hairy, spindle-shaped, petiolate galls on *Ulmus davidiana* var. *japonica* (also mentioned as *U. japonica,* or *U. campestris* var. *major*) known as *T. fusiformis* Mats., 1917. MONZEN (1929), erroneously using the name *T. yezoensis* Mats., successfully transferred this aphid to *Echinochloa* and *Digitaria*, but does not describe the results in detail. TANAKA (1961) suggested that this is the same as *T. nigriabdominalis* from Rice roots. The embryos in emigrants show 6 hairs on abd. tergite VII, and very long and fine spinal and pleural hairs on abd. tergite VII, and very long and fine spinal and pleural hairs of 0.065 mm and longer on abd. segments I-VI.

II. Material from roots of Rice from Japan sent by Dr. Tanaka as *T. nigriabdominalis* Sasaki. The populations on roots of Rice in Japan in the autumn seem to develop sexuparae. My material consists of samples from 4 localities, one collected 5.VI. and clearly from an anholocyclically overwintered colony (alatoid nymphs present), three collected in the middle

of September, and partly consisting of sexuparae. Embryos have 6 hairs on abd. tergite VII, and if taken from apterae: on the more anterior segments thorny spinal and pleural hairs of 0.030-0.045 mm long; if from alatae: 0.052-0.067 mm long. Adult apterous exules on abd. tergites VII have 4-6, mostly 6, short (0.015-0.025), thin, spiny, rarely equally long, hairs besides the large marginal hairs; anterior tergites with very short (0.004-0.015) thin, curved spinal and pleural hairs on very small round, pigmented sclerites about 0.010 mm in diameter; subanal plate with 24 (sample of 5.VI) to 55 very thin hairs besides those on the gonapophyses and the 4 long and stout hairs.

III. Material from India and Indonesia from various Gramineae including Rice and Sugar-cane. Embryos have 6 hairs on abd. tergite VII, and are similar to those of II. Adult apterous exules on abd. tergite VII have 4-6, all, or partly (spinal ones), rather long (0.035-0.045) and spiny hairs besides the large marginal hairs; anterior tergites with the spinal and pleural hairs as in II, sample 5.VI; but subanal plate with only 14-22 small extra hairs.

IV. Material from Africa and North America from various Gramineae including Rice and Sugar-cane. Embryos with only 4 stout hairs on abd. tergite VII. Apterous exules normally with only 2 stout spinal hairs on tergite VII besides the similar marginal hairs. Subanal plate with not more than 15 extra hairs on subanal plate.

For group II, only known from Japan, the name *Tetraneura nigriabdominalis* (SASAKI, 1899) has to be used, in accordance with TANAKA (1961). Group III in several respects differs from group II, particularly by the much smaller number of extra hairs on the subanal plate. However, also in anholocyclically living specimens of group II from Japan the number of extra hairs on the subanal plate is lower, and therefore group III, which apparently is *hirsuta* Baker, might be anholocyclic, somewhat extraordinary clones of II.

Group I looks quite different from groups II and III when embryos from apterous exules are compared with those from alate group I. The constant difference in structure and length of the embryonic hairs seems to suggest that different species are involved. But this difference dwindles when one examines embryos from alate virginoparous exules from group III. For they do not differ so much from those of *fusiformis*. It would seem logical, therefore, to accept Tanaka's opinion that *T. fusiformis* is a synonym of *T. nigriabdominalis*, but there is some doubt left.

MORDVILKO (1924, 1935) described and figured a gall, and embryos from emigrants, of *T. chinensis* Mordvilko, 1924. The hind tarsal claws show that *T. chinensis* is a *Tetraneurella,* and unfortunately he does not state whether it had smooth or spinulose tarsi in embryos. In 1935 Mordvilko declares *T. chinensis* a synonym of *T. hirsuta* Baker, and, with a query, of *T. fusiformis* Mats. But the gall drawn by Mordvilko could not possibly have been made by *T. fusiformis.* Without re-examination of Mordvilko's material of *T. chinensis* and its embryos, or without the examination of the adult progeny of *fusiformis* emigrants, one cannot be certain whether *T. fusiformis* or *T. chinensis* is part of the cyclus of *T. nigriabdominalis.* The fundatrices and emigrants of *T. fusiformis* are described in this paper as being part of the cyclus of *T. nigriabdominalis.*

Tetraneura oryzae v.d. Goot in Van Heurn, 1923 belongs to group III, according to Javanese material from Rice roots, and this becomes a synonym of *T. nigriabdominalis.*

I have only 7 samples of group IV, but they are homogeneous as far as the chaetotaxy of the adults and embryos goes. I have not seen African or American embryos with 6 hairs on abd. tergite VII. Therefore the African and American form of *nigriabdominalis* is described hereafter as a subspecies.

It is necessary to point out that it is very difficult to distinguish *T. nigriabdominalis* from *T. akinire* Sasaki. If embryos or first instar larvae born from emigrants or virginoparous exules are available there is no problem; the ones with smooth tarsi are *T. akinire,* those with spinulose tarsi *T. nigriabdominalis.* But sometimes, in young embryos inside adults in poor slides, the spinules on the tarsi can hardly be seen. Then an embryo has to be taken out and examined, e.g., in KOH 10%. Adult virginoparous exules without embryos can be separated by the hairs on abdominal tergite VIII and on the subanal plate, if the latter happens to be in the right position. Sexuparae I can not reliably separate if their subanal plates cannot be examined. The antennae are longer, and the number of rhinaria is higher in sexuparae of *T. akinire* than in those of *T. nigriabdominalis,* but there is an overlap.

It is remarkable that this species with its world-wide distribution has never been recorded from Europe.

T y p e s. Sasaki's material as far as known is lost. I have selected a neotype in which embryos and the subanal plate can easily be examined. Neoholotype: Apterous viviparous female (no. 1 of measurements), from roots of *Oryza sativa,* Mamada, Tochigi Prefecture, Japan, 6.IX.'59, leg.

M. Inaizumi, Tanaka slide no. 13. Neoparatypes: Apterous viviparous females with data as for neoholotype, Tanaka slides no. 13-17. Types of *Dryopeia hirsuta* Baker, 1921 in U.S. Nat. Museum, Washington, D.C. Types of *T. chinensis* Mordvilko, 1924, probably in Zool. Inst. of the U.S.S.R. Acad. Sciences, Leningrad. Types of *T. fusiformis* Matsumura, 1917 unknown. Types of *T. oryzae* v.d. Goot in Van Heurn, 1924 lost.

Tetraneura (Tetraneurella) nigriabdominalis subsp. **bispina** subspec. nov.

Apterous viviparous female.

Like apterous exules of the main species, but with fewer hairs. Ant. segment II with 2-3 hairs; segment III as far as recognizable rarely with 1 hair; penultimate segment with 11-17 hairs. Dorsal hairs on the anterior abd. tergites at least partly longer than in main species, to 0.030 mm long or longer. Abd. tergite VII with 2 large hairs besides the marginal hairs, not or exceptionally with one additional small hair. Subanal plate with only 8-16 thin hairs besides the 4 thick ones and those on the gonapophyses.

Measurements in mm.

No.	Length body	Ant.	Antennal segments			
			III	IV	V	VI
1	1.67	0.38	0.07	0.14	0.05	
2	1.94	0.40	0.07	0.03	0.14	0.06
3	1.96	0.39	0.08	0.15	0.05	
4	1.75	0.35	0.07	0.13	0.05	
5	1.85	0.40	0.07	0.15	0.05	
6	1.69	0.34	0.18	0.43		

(1-2, sifted from soil, near Nairobi, Kenya, 5.VII.'62, leg. H. Franz no. OA 2; 3-5, from *Pennisetum* sp., Natchingwea, Tanganyika, 6.V.'53, leg. V.F. Eastop no. 4812; 6, from grass roots, Natchingwea, Tanganyika, 2.V.'53, leg. V.F. Eastop no. 4809).

Alate viviparous female (virginoparous exules).

Like those of the main species, but with 2 spinal hairs on abd. tergite VII, and 10-20 additional hairs on the subanal plate.

Measurements in mm.

No.	Length body	Ant.	Antennal segments				Rhin. on segments		
			III	IV	VI	V	III	IV	V
1	1.70	0.60	0.19	0.06	0.18	0.06	11 & 12	4 & 4	9 & 8
2	2.14	0.66	0.22	0.07	0.15	0.06	16 & 17	4 & 3	11 & 12
3	1.88	0.62	0.20	0.06	0.19	0.05	13 & 14	4 & 4	11 & 12

(1, trapped, Muguga, Kenya, XII.'52, leg. V.F. Eastop; 2, from *Dactyloctenium aegyptium,* Nairobi, Kenya, 15.VI.'51, leg. G. de Lotto no. 1049 or 1050; 3, yellow trap, S.d.C. Vegas, Cuba, VI.'66, leg. D. Tashev).

E m b r y o s taken from apterous exules, or larvae I (fig. 9, 23, 42, 56).

Much like those of the main species, but ant. segment IV with 11-15 hairs, abd. tergite VII with 4, rarely 5 hairs, and VI with mostly 6, but sometimes 5 or 4 hairs.

E m b r y o s taken from alate exules.

Much like preceding ones, but all dorsal hairs on abd. segments I-V with a very thin apical part and up to 0.105 mm long marginally, 0.075 mm spinally.

D i s c u s s i o n. The available material, from Kenya, Tanzania, Nigeria, Cuba and Louisiana, U.S.A., strongly suggests that it does belong to one clone. Nutritional or climatic influences could hardly cause such a difference in hairiness between the Indo-Malesian and Japanese material on one hand, the African-American material on the other hand. Particularly the embryonic chaetotaxy made me consider this a subspecies: in adults of the Indo-Malayan material there is enough variability to ensure the occurrence of occasional apterous exules with only 2 spinal hairs on abdominal tergite VII.

As far as I know, sexuparae of this subspecies are not known, which, of course, does not mean that they could not be produced. Inhabitants of galls on *Ulmus* that could be linked with the subspecies also are unknown.

The occurrence in both Africa and America is remarkable. As in the Nearctic no indigenous *Tetraneura* is known, one is tempted to think that it was imported from Africa to America. But that leaves the question how it ever came to Africa, where it seems to be common enough. Possibly all records of *T. hirsuta* Baker from Africa relate to this subspecies.

Types. Holotype: Apterous viviparous exul (no. 1 of measurements) sifted from soil near Nairobi, Kenya, 15.VII.'62, leg. H. Franz, no. AO 2. Paratypes: One apterous viviparous female with data as for holotype, and apterae viviparae from *Pennisetum* sp., Nachingwea, Tanganyika, 6.V.'53, leg. V.F. Eastop no. 4812. With the types are first instar larvae.

Tetraneura paiki spec. nov.

Alate viviparous female (sexupara; from one specimen).

Head capsule with about 22 hairs of which the dorsal ones are fine and up to 0.045 mm long; and with a pair of ventral wax glands, and frontal wax glands, all consisting of one stippled cell. Antennae (fig. 30) not quite 1/3 of length of body, with segments V and VI completely spinulose; rhinaria vide measurements; segment II with 3 and 5 stout, almost thorny, curved hairs; segment III with 10 and 14 hairs; segment IV with 1 and 2 hairs; segment V with 10 and 11 hairs, segment VI on basal part with 2 hairs; all these hairs stout, gradually tapering to a very acute point, spreading at angles of about 70°, and about 0.040-0.052 mm long. Last rostral segment about 0.13 mm long, with either 5 or 6 hairs besides the 3 subapical pairs, just shorter than second joint of hind tarsi (0.14 mm long). Wax glands quite distinct on abdomen, the minute spinal and pleural ones, where present, consisting of a single round cell, the ventro-lateral ones consisting of a round to oval stippled cell, on tergite VII about 0.011 x 0.022 mm, with a more or less crenulated margin; against the periphery of some of these glands 1-3 minute cells less than 0.003 mm in diameter. Dorsal hairs on abdomen sparse; spinal hairs on tergite I thin, about 0.013-0.018 mm long; the two spinal hairs on tergite VII about 0.070 mm; the two hairs on tergite VIII about 0.085 mm long; on each of the anterior segments one pair of sharply bent marginal hairs of about 0.035 mm long, and a pair of nearly straight hairs of about 0.018 mm long, more rarely also with a bent additional hair of about 0.010 mm long; tergite VII with a single pair of marginal hairs of about 0.075-0.080 mm long; tergite VIII without marginal hairs. Legs normal; dorsal hairs half way hind tibiae rather spreading, to 0.015 mm long, nearly as long as the local diameter; hairs on first joint of hind tarsi very long, half as long as second joint, and the lateral hairs on first joint of fore tarsi only little shorter. Pterostigma of wings greyish with not much darker posterior border. Siphunculi very low, ring-shaped, with an outer diameter of 0.035 mm. Cauda with 2 hairs. Subanal plate with 4 long hairs besides those on the rudimentary gonapophyses.

Measurements in mm.

Length body	Ant.	Antennal segments				Rhin. on segments		
		III	IV	V	VI	III	IV	V
2.14	0.64	0.22	0.06	0.16	0.07	14 & 16	3 & 4	10 & 9

(from yellow trap, Suwon, Korea, 27.IX.'67, leg. W.H. Paik).

Discussion. Unfortunately only a single sexupara from a yellow trap, sent for identification by Professor Woon Hah Paik, is available. But this specimen differs so much from the other species that I venture to describe it.

The small number of marginal hairs on the abdomen suggests that embryos with mouth parts will have a single pair of marginal hairs, and that also the apterous exules are not very hairy. The type of marginal wax glands, however, is only known from a group of species that is exceptionally hairy, the *T. yezoensis* group, which also shows a conspicuously long and hairy last rostral segment in its sexuparae. It is improbable that rostrate embryos have enlarged hind tarsi, because in *Tetraneura* with that character, subgenus *Tetraneurella,* all known sexuparae have very large, foamy wax glands. The long hairs on the antennae suggest *T. basui* spec. nov., of which alatae are not yet known. However, the type of wax glands in apterae and embryos of *T. basui* differs very considerably from that in the sexupara of *T. paiki* spec. nov., the number of antennal hairs differs considerably, and probably more important, the subanal plate in *T. basui* has additional hairs besides the 4 long hairs and those on the gonapophyses.

The species is named for Prof. Woon Hah Paik whose excellently illustrated book on Korean aphids is an invaluable guide for those taking an interest in Far Eastern aphids.

Types. Holotype: Alate sexuparous female, from yellow trap, Suwon, Korea, 27.IX.'67, leg. W.H. Paik. In the author's collection.

Tetraneura (Tetraneurella) polychaeta spec. nov.

Fundatrix (from one specimen).

Body small, 1.68 mm, roundish, without wax glands, on abd. segments I-V with single, fine marginal hairs of 0.048 mm and single spinal and pleural hairs of 0.026-0.035 mm; no spinal hairs on tergite VII. Antennae 0.25 mm long, of 3 or indistinctly 4 segments, with very few hairs.

Last rostral segment short, 0.087 mm, triangular, acute, with 4 hairs besides the 3 subapical pairs. Fore and middle tibiae on distal half with a few spinules, but tarsi smooth.

Alate viviparous female (emigrants from gall).

Body about 2.00-3.15 mm long, rather uniform in size within one gall. Head capsule with about 32-42 hairs of 0.012-0.022 mm long, without ventral wax glands. Antennae (fig. 36) a little more than 1/3 of length of body, with only segment VI and the very apex of V spinulose; segment I with 5-7, II with 7-10 hairs; segment III with 10-18 hairs, and about 20-32 rhinaria of which usually only 1-4 encircle half or more than half of the segment, the rest shorter and more or less alternating; segment IV with 5-8 hairs and 3-10 similar rhinaria; segment V with 12-18 hairs and 9-15 mostly parallel and half-circumference rhinaria. Last rostral segment about 0.10-0.12 mm long, with 14-18 hairs besides the 3 subapical pairs, nearly 2/3 of second joint of hind tarsi. Wax glands on thorax or abdomen not found, probably absent. Legs moderately short; dorsal hairs halfway hind tibia acute, thorny, about 0.016-0.020 mm long; tibiae only at the very apex dorsally spinulose. Siphunculi absent. Abd. tergite VIII with 2 hairs. Cauda with 2 hairs. Subanal plate with 6-7 rather long hairs besides those on the gonapophyses. Most specimens with short dark sclerotic bars on tergites II-V.

Measurements in mm.

No.	Length body	Ant.	Antennal segments				Rhin. on segments		
			III	IV	V	VI	III	IV	V
1	3.09	1.07	0.40	0.12	0.27	0.12	26 & 27	6 & 6	10 & 10
2	3.04	1.05	0.37	0.16	0.26	0.11	20 & 23	10 & 6	11 & 11
3	2.10	0.78	0.29	0.10	0.19	0.09	25 & 28	6 & 5	9 & 10
4	2.02	0.78	0.30	0.10	0.19	0.09	23 & 30	5 & 4	10 & 12
5	3.15	1.07	0.39	0.12	0.29	0.12	29 & 30	7 & 8	13 & 12
6	2.96	1.06	0.39	0.14	0.28	0.11	27 & 32	8 & 9	15 & 12
7	2.10	0.89	0.31	0.11	0.24	0.10	25 & 27	6 & 6	14 & 13
8	2.13	0.86	0.29	0.11	0.23	0.10	22 & 25	4 & 3	11 & 12
9	1.34	0.73	0.26	0.09	0.18	0.09	28 & 31	5 & 5	8 & 10
10	1.43	0.73	0.29	0.09	0.19	0.09	20 & 25	4 & 4	9 & 10

(from five galls on *Ulmus villosa,* Balakot, West Pakistan, 19.IV.'67, leg. M.A. Ghani; 1-2, gall no. 884; 3-4, no. 886; 5-6, no. 887; 7-8, no. 888; 9-10, no. 885).

Alate viviparous female (sexupara).

One damaged specimen that perhaps belongs here. Head capsule with about 55-60 hairs and one ventral wax gland of 0.023 x 0.015 mm. Ant.

segment I with 3 hairs; II with 13-15 hairs; III with 18-21 hairs and 22 & 22 rhinaria; IV with 9-11 hairs and 5 & 6 rhinaria, V with 27 ? hairs and 28 and ? rhinaria. Last rostral segment 0.22 mm long, with 12 hairs besides the 3 subapical pairs, about 1 1/3 times second joint of hind tarsi. On abd. tergites I-V marginal hairs very numerous, 0.052-0.065 mm long with one very much stouter hair of 0.060-0.075 mm long; all these hairs, especially the thick ones, rather conspicuously bent at about basal 1/3 part and from thereon straight; spinal and pleural hairs scarce, only about 0.013-0.030 mm long; tergite VII with about 10-12 marginal hairs but only 2 short spinal hairs; tergite VIII with 2 long bent hairs. Cauda with 2 hairs. Subanal plate with 6 long hairs. Ventro-lateral gland round or oval, consisting of one stippled cell 0.015-0.024 mm in diameter.

Measurements in mm.

No.	Length body	Ant.	Antennal segments			
			III	IV	V	VI
1	2.68	?	0.30	0.10	0.23	?

(trapped on ship, Yellow Sea, Korea, 7.X.'63, leg. J. C. Harnell, B. M. no. 339/54).

E m b r y o s taken from spring migrants, or larvae I (figs. 1, 44, 57, 58).

Antennae of 5 segments, when stretched about 0.12 mm long, of which the extremely long segment IV is 0.065 mm; segment I with 4-7 long hairs of up to 0.075 mm and one short hair; II with 10-14 long hairs; III with 5-7 hairs; IV with 30-38 hairs, spinulose on distal one third part; V with 3-4 hairs basad the primary rhinarium, the latter with 3-furcated membrane. Abd. tergites I-V with marginal hair groups consisting of 4-7 hairs each in which the longest hair is 0.060, the shortest 0.013, or 0.022, or 0.030 mm long; spinal and pleural hairs 0.052 mm long, 6 per tergite, but in addition 0-4 or 5 other, shorter hairs of which mostly a few are 0.006 mm long or shorter; tergite VII with 2 spinal hairs, and 4-5 hairs in each marginal group, sometimes with 1-2 very small additional pleural hairs; tergite VIII with 2 hairs of 0.10-0.11 mm long; cauda with 2 hairs of 0.030 mm; subanal plate with 8-10 stout hairs. Wax glands very numerous and very distinct but varying between clones; in sample 884, 885, 886 and 887 abd. segment II-VI with spinal, marginal and ventro-lateral wax glands of similar size and structure, roundish, 0.014-0.026 mm diameter, with evenly stippled surface; but the ventro-lateral ones on segment I oval, e.g., 0.016 x 0.042 mm, and often dupli-

cated; also on other segments marginal glands often with a very small additional, free gland (0.004-0.009 mm diameter) beside it, dorsad; spinal glands on tergites VI and III transversely oval; ventro-lateral glands very rarely with 1-2 very small cells in contact with their periphery. In sample Ghani 888 arrangement and size of glands as in the others, but their surface with a very faint reticulation that divides the stippled area into 5-24 cells; besides in line with the stigmal pori groups of 2-20 small cells without a common rim and these groups mostly free, but sometimes in contact with a circular rimmed gland. Last rostral segment (extended) 0.20 mm long, with 14-18 hairs besides the 3 subapical pairs. Hind tarsal claws equal in length, 0.085-0.012 mm long, in new born larvae only just longer than the hind tarsal joint; all tarsi and tibiae quite smooth.

Discussion. This aphid which in some galls is larger than any other material from *Ulmus* I have seen, cannot be associated with a form known from grasses with long embryonic hind tarsal claws, and therefore it is described as a new species. The difference in size of body between samples from different galls is very striking, but even more so the differences in ventro-lateral wax glands between clones comparable in size of body. One might think that the differences in wax glands were caused by greater or lesser maturity of the embryos; but of sample 884 some born first instar larvae are available and they do not differ in wax glands from the embryos. The bodies in sample 885 are smaller than in others, and 6 alatae together contained only one embryo. In this sample the fundatrix was present.

About the exules one can predict that they have a long last rostral segment with many hairs, and very hairy antennae.

The trapped sexupara looks like *T. yezoensis* but has too many rhinaria, a different interrelationship between antennal segments III and V, and a different chaetotaxy of the abdomen. I have tentatively placed it under the heading *T. polychaeta* spec. nov.

Unfortunately no data are available on the type of gall produced by this aphid. The host was given as *Ulmus laevigata,* but I found that this is a synonym of *U. villosa.*

Types. Holotype: Alate viviparous female (no. 1 of measurements) from gall on *Ulmus villosa,* Balakot, West Pakistan, 19.IV.'67, leg. M.A. Ghani no. 884. Paratypes: Alate viviparous females with collecting data as for holotype, and with sample numbers 885, 886, 887 and 888. Types in the author's collection.

Tetraneura radicicola Strand, 1929

1927. Takahashi, R., Aphid. Formosa, 4 : 54, *Tetraneura* sp.
1929. Strand, E., Acta Univ. Latviensis, 20 : 22, *Tetraneura radicicola.*
1930. Mordvilko, A.K., Compt. Rend. Acad. Sc. U.S.S.R. (A), 8 : 279, *Tetraneura takahashii.*
1961. Carver, M. & Basu, A. N., Proc. R. Ent. Soc. London (B), 30 : 83-84, *Tetraneura heterohirsuta* (partim).

Alate viviparous female (emigrants from galls).

Body about 1.50-2.00 mm long. Head capsule with about 60-65 scattered hairs of 0.025-0.035 mm long, without wax glands. Antennae (fig. 31) about 1/3 of length of body, with segments V and VI spinulose; segment I with 4-6 hairs; segment II with 9-13 hairs of about 0.030 mm long; segment III with 9-14 rhinaria and 4-10 hairs; segment IV with 2-5 rhinaria and 6-9 hairs; segment V with 5-8 rhinaria and 11-21 hairs; primary rhinarium on segment VI not much branched. Last rostral segment about 0.11-0.12 mm long, with 12-14 hairs besides the 3 subapical pairs, as long as second joint of hind tarsi. Only very small ventro-lateral wax glands present, consisting of a single round cell of 0.004-0.005 mm diameter. Legs short but rather slender; dorsal hairs halfway the hind tibiae about 0.030-0.035 mm long. Stigma of fore wings rather evenly dark. Siphunculi absent. Tergite VIII with 5-9 hairs. Cauda with 4 hairs. Subanal plate with about 8-10 hairs similar to those on the gonapophyses, and these hairs not separable from the gonapophysal ones.

Measurements in mm.

No.	Length body	Ant.	Antennal segments				Rhin. on segments		
			III	IV	V	VI	III	IV	V
1	1.70	0.51	0.18	0.06	0.12	0.06	10 & 13	3 & 3	8 & 8
2	1.61	0.55	0.18	0.07	0.13	0.06	14 & 14	3 & 3	5 & 7
3	1.78	0.54	0.16	0.07	0.13	0.07	12 & 16	4 & 4	5 & 9
4	2.21	0.66	0.21	0.09	0.17	0.09	14 & 16	4 & 5	7 & 6

(1-4, from *Ulmus davidiana* var. *japonica,* Sapporo, Hokkaido, Japan, 24.VI.'61, leg. S. Takagi).

Apterous viviparous female (exules).

Body rather large, 2.00-3.50 mm long (Mordvilko, 1935). Dorsum and venter covered with an extremely large number of fine hairs all of the same type, 0.050-0.080 mm long, on abd. tergite I at a density of about 20 per (0.1 x 0.1) mm^2, with only on tergite VIII, or VIII and VII,

marginally and spinally very stout hairs of up to 0.150 or 0.200 mm long; tergite VII with marginal groups of 7-13 hairs, and about 8-14 spinal and pleural hairs; tergite VIII with 4-8 stout hairs, not with lateral small hairs. Antennae about ¼ of length of body, of 5 or 6 segments, with last and penultimate segment on the underside very dispersely spinulose; segment I with 5-7 hairs similar to those on body of about 0.045-0.060 mm long; II with 16-26 hairs, III with about 40-45 hairs, IV with about 37-60 hairs; base of V with 2 long hairs and one short hair. Last rostral segment long, 0.20-0.25 mm, with 18-30 hairs besides the 3 subapical pairs. Wax glands simple, consisting of one round to oval, often markedly crenulated or partly subdivided (lines running towards, but not to the center) cell; spinal glands round, also those on VII small, not over 0.015 mm in diameter, but ventro-lateral glands oval, to 0.048x0.022 mm but mostly much smaller; surface indistinctly stippled. Tibiae thick and hairy like the rest of the legs; hind tarsi 0.085 mm long. Cauda with 2 hairs. Subanal plate with 12-14 long and stout hairs besides the smaller and thinner ones on the gonapophyses.

Measurements in mm.

No.	Length body	Ant.	Antennal segments			
			III	IV	V	VI
1	2.36	0.53	0.14	0.19	0.05	
2	2.43	0.59	0.16	0.21	0.06	
3	3.00	0.69	0.10	0.09	0.28	0.05
4	2.79	0.64	0.10	0.07	0.26	0.05
5	2.83	0.73	0.09	0.09	0.26	0.05
6	2.66	0.62	0.10	0.06	0.22	0.05

(1, from *Imperata arundinacea,* Kalimpong, India, 7.III.'58, leg. A.N. Basu, 174 (2), paratypes of *T. heterohirsuta* Carver & Basu; 2, from *Imperata arundinacea,* Kepong, Malaya, 12.XII.'62, leg. H.T. Pagden C.I.E. 13183; 3-4, from grass roots, Cinnamara, Assam, India, 1.III.'67, leg. Tea Research Centre, BM no. 206/67; 5-6, like 3-4 but 1.VI.'67, BM no. 379/67).

Alate viviparous female (virginoparous exules).

Body 2.00-2.40 mm long. Head capsule with about 74-96 scattered, fine hairs of about 0.040-0.052 mm long, with rather large ventral wax glands, but without developed dorsal glands. Ant. segment I with 6-9 hairs; segment II with 15-24 hairs; segment III with 13-29 hairs and 8-12 rhinaria; segment IV with 11-19 hairs and 2-3 rhinaria; segment V with 40-65 hairs and 9-14 rhinaria. Last rostral segment about 0.21-0.23 mm

long with 24-33 hairs besides the 3 subapical pairs, about 1½ times as consisting of oval clusters of indistinctly separated, markedly stippled, rounded cells surrounded by a very indistinct crenulated rim, the largest gland about 0.026 x 0.045 mm, the smallest about 0.016 mm in diameter. Tibiae very hairy, typically thinnest on distal 1/3 part, distad thicker; hind tibiae dorsally halfway their length with hairs up to 0.045 mm long. Marginal hairs on abd. tergites I-V in large groups, like the other dorsal hairs very thin, up to 0.080 mm long; on tergite VII 6-8 stout spinal, pleural and marginal hairs of 0.095-0.120 mm long; tergite VII with 4-6 such hairs of which the outer pair is the largest, not with very fine additional hairs. Cauda with 2-5 hairs.

Measurements in mm.

No.	Length body	Ant.	Antennal segments				Rhin. on segments		
			III	IV	V	VI	III	IV	V
1	2.36	0.73	0.21	0.09	0.26	0.05	10 & 11	3 & 3	11 & 11
2	2.30	0.70	0.20	0.09	0.28	0.05	11 & 12	2 & 3	10 & 14
3	2.12	0.66	0.19	0.07	0.21	0.05	8 & 10	3 & 3	10 & 8
4	2.00	0.57	0.16	0.06	0.18	0.05	8 & 8	2 & 3	11 & 10
5	2.04	0.65	0.19	0.07	0.20	0.05	10 & 11	3 & 3	9 & 9

(1, from yellow trap, Kakami, Nepal, VI.'66, leg. K.C. Sharma, B.M. no. 543/66; 2, from Tobacco, Kandy, Ceylon, 8.I.'62, leg. E. Judenko, B.M. no. 261/62; 3, from trap, Davao, Philippines, III.'63, leg. M.R. Gavarra, B.M. no. 351/63; 4-5, from yellow trap, Brisbane, Australia, V-IX.'62, leg. R. D. Hughes, B. M. no. 1962/16).

E m b r y o s taken from emigrant.

Antennae of 5 segments, with segments III and IV spinulose. Segment I with 6-7 hairs of about 0.045 mm, segment II with 12-14 hairs, segment III with 7-9 hairs, IV with 32-35 hairs. Last rostral segment over 0.180 mm long (not yet stretched), with 24 hairs besides the 3 subapical pairs. Abd. segments I-VI with groups of 10-15 marginal hairs, of which, especially from segment V caudad, one is conspicuously stouter and longer (0.075-0.100 mm) than the others of which the smallest is about 0.025 mm long; between the marginal groups about 22-28 hairs of which 2 spinal ones and 2 pleural ones are noticeably thicker and longer (0.050-0.070 mm) than the others (0.016-0.045 mm); tergite VII with about 22-30 hairs of which one marginal pair and 2 spinal ones are much stouter and longer than the others; tergite VIII with 2 long spinal hairs and between these 2-4 small hairs, laterally with 4-6 small hairs. Cauda with 4 hairs. Subanal plate with probably 6 large hairs, and 6

smaller hairs, in total 12-14 hairs. Wax glands distinct, ventro-lateral glands round to oval with one large, crenulated, stippled, cell with occasionally 1-2 very small inconspicuous cells against the periphery; the largest of these glands on the head (0.030 mm in diameter), those on abd. segments I-V about 0.015 mm in diameter; spinal and pleural glands smaller than the socket of a dorsal hair, about 0.002 mm in diameter. Hind tarsal claws 0.040 mm long. Tarsi and a large portion of the tibiae strongly spinulose.

Embryos taken from apterous exules, or larvae I (fig. 60).

I. from Kepong, Malaya, and Assam, India. Antennae (fig. 43) of 5 segments, with segment IV and V spinulose; segment I with 8-10 long hairs and one short one; segment II with 13-14 hairs; III with 9-11 hairs; IV with 50-55 hairs; basal part of VI with 2 long hairs and one short one; hairs about 0.060 mm long. Last rostral segment when stretched 0.225-0.245 mm long, with 18-22 hairs besides the 3 subapical pairs. Abd. segments I-V with marginal groups of 10-14 hairs all of about the same shape; number of spinal and pleural hairs about 40-50. Tergite VII with about 12 spinal and pleural hairs, 8-12 marginal hairs of which 2 are very much longer, tergite VIII with 4-8 hairs; cauda with 2-3 hairs; subanal plate with 10-12 long hairs. Wax glands (fig. 20) as in preceding morph, slightly smaller, and none with a very small cell against its periphery. Hind tarsal claws 0.039 mm long. Hind tarsi 0.090-0.110 mm long, like all other tarsi and about distal half of all tibiae spinulose (fig. 8).

II. *heterohirsuta* from Kalimpong, India. Antennae of 5 segments, segment I with 5 hairs, segment II with 9-10 hairs, segment III with 8-9 hairs, segment IV with about 30-34 hairs. Marginal hairgroups of 10-15 hairs, caudad with one stouter hair of up to 0.11 mm long, the others about 0.030-0.032 mm long; between the groups about 20-25 spinal and pleural hairs; tergite VII with 12-14 hairs of which 2 spinal and 2 pleural hairs are extra long (0.12 mm); tergite VIII with 2 stout spinal hairs and between those 2 short hairs. Cauda with 2 hairs. Subanal hairs cannot be examined, but more than 7 present. Wax glands as in preceding embryos, but slightly larger, without additional minute cells. Last rostral segment not stretched 0.18 mm long, with about 20 hairs besides the 3 subapical pairs. Hind tarsal claws 0.041 mm long. Tarsi spinulose.

Embryos from alate virginoparous exules.

Chaetotaxy can hardly be examined in body of mothers because of very great hairiness of both. Those in no. 4 and 5 agree with those from

apterous exules from Kalimpong; those in no. 1 and 3 more strongly resemble those in apterae from Kepong with the difference that tergite VII and VIII have some hairs distinctly longer and stouter than the others. All embryos have occasional minute cells against the periphery of the ventro-lateral wax glands.

Discussion. The use of studying embryos as a clue to the host alternation is best illustrated in this species. Only the hairiness of the head in emigrants from galls suggests some relationship with *T. radicicola* from grass roots. But the length and chaetotaxy of the last rostral segment, as well as the interrelations of the antennal segments V and VI are so different between emigrants from galls, and alate virginoparous exules, that one could not guess that this might be the same species. Yet the embryos inside the emigrants unmistakably show the same rostral structure and chaetotaxy as the embryos in exules.

On p. 85 the interrelationship between this species and *T. yezoensis* Mats. is discussed. I assume that *T. heterohirsuta* Carver & Basu from India is a synonym of *T. radicicola* Strand. EASTOP (1966) suggests that the two might be different, because *T. heterohirsuta* types from Kalimpong have fewer antennal and rostral hairs, and some very long hairs on the posterior abdominal segments. These long hairs are not mentioned in Takahashi's original description of the *Tetraneura* sp. that Strand named *radicicola,* and absent in Eastop's sample from Kepong, Malaya. But in the Essig collection at Berkeley, Calif., I found some specimens of Takahashi's original sample with very long hairs indeed on tergites VII and VIII, though they are absent in other specimens. Also the four measured exules from Assam, India, show these long hairs while their number of antennal hairs is among the highest. Eastop's suggestion that genuine *T. radicicola* (and *T. heterohirsuta*) might be restricted to *Imperata* can hardly be true, for TAKAHASHI (1931) mentions that his material came from *Miscanthus* sp. and *Saccharum offinarum.* And in the are where the species was found on *Ulmus, Imperata,* as far as I know, does not occur.

Types. Those of *Tetraneura radicicola* Strand, if types have been at all selected, in Taiwan Agric. Res. Inst., Taipei, Taiwan (Formosa). Those of *T. takahashii* Mordv. probably in the Zool. Inst. of the U.S.S.R. Acad. Sc., Leningrad. Holotype of *T. heterohirsuta* Carver & Basu, apterous viviparous female, from *Imperata arundinacea,* Kalimpong (W. Bengal), India in Agr. Res. Inst. Calcutta, India; paratype in the author's collection.

Tetraneura (Tetraneurella) sorini spec. nov.

Alate viviparous female (emigrant).

Body about 1.60-2.00 mm long. Head capsule with only 18-20 hairs of 0.024-0.045 mm long, without wax glands. Antennae (fig. 32) 2/7-1/3 of length of body, with segment VI and distal 2/3 part of V spinulose; segment I with 3-4 inconspicuous, fine, hairs of 0.024 mm long; segment II with 3-8, mostly 5 hairs; segment III with 3-6 hairs and 7-10 rhinaria; segment IV with 1-3, usually 1 hair and 2-5 rhinaria; segment V with 14-19 hairs of 0.015 mm long and 6-9 rhinaria of which the terminal one is nearly always fused to a very irregular structure. Last rostral segment rather pointed, only 0.080-0.090 mm long, with 4 hairs besides the 3 subapical pairs, nearly 2/3 of second joint of hind tarsi. Dorsal hairs hard to see because of embryos, very scarce; marginal hairs 2 pairs in tandem, not very thick, on abd. tergites I-V about 0.030-0.045 mm long, sometimes rather sharply bent at basal 1/3 part; tergite VII with 6 hairs; tergite VIII with 4-8 hairs of 0.040-0.055 mm long. Wax glands not detectable and almost certainly absent. Siphunculi absent. Cauda with 2, rarely 3, hairs. Subanal plate with 4-12 long hairs besides the slightly shorter ones on the gonapophyses.

Measurements in mm.

No.	Length body	Ant.	Antennal segments				Rhin. on segments		
			III	IV	V	VI	III	IV	V
1	1.88	0.55	0.19	0.07	0.14	0.07	7 & 9	3 & 2	6 & 6
2	1.62	0.55	0.18	0.07	0.15	0.06	8 & ?	4 & ?	8 & ?
3	1.73	0.53	0.17	0.06	0.14	0.06	8 & 9	2 & 2	6 & 6
4	1.95	0.57	0.20	0.06	0.16	0.06	7 & 8	3 & 2	9 & 9
5	1.72	0.57	0.18	0.07	0.16	0.07	7 & 8	3 & 5	6 & 7
6	1.90	0.56	0.19	0.07	0.14	0.07	10 & 10	4 & 4	8 & 8

(1-6, from *Ulmus* sp., Sapporo, Japan, 24.VI.'61, leg. S. Takagi).

Embryo taken from emigrant.

Antennae of 5 segments, with segments IV-V distinctly spinulose and segment III with some spinules; segment I with rather stout hairs with fine apices of 0.090-0.095 mm long and one tiny hair of 0.009 mm long; segment II with 2 very long hairs and one slightly smaller one; segment III apparently without hairs; segment IV with 13-17 hairs of about 0.080

mm long; membrane of primary rhinarium on segment V probably 2-branched. Last rostral segment 0.140-0.150 mm long, with 4-6 hairs besides the 3 subapical pairs. From abd. tergites I-VI single pairs of marginal, pleural and spinal hairs present, tergite VII only with marginal and spinal hairs, tergite VIII only with spinal hairs; marginal hairs stout but with very thin apex, about 0.140 mm long; spinal hairs on anterior tergites much thinner, 0.065-0.075 mm long, but from tergite VI caudad suddenly increasing in thickness and length to at least the size of the marginal hairs; pleural hairs about as thick as the anterior spinal hairs but 0.045-0.070 mm long and rather strongly bent or curved. Cauda with 2 hairs. Subanal plate with 4 stout hairs. Wax glands not very distinct, but apparently of one type of cell of unequal size; ventral glands on head of about 7-9 cells; ventro-lateral glands on prothorax 0.050 x 0.026 mm, of about 12 cells; those on abd. segment I 0.037 x 0.023 mm, of about 10 cells, of which the largest is 0.011 mm, the smallest 0.005 mm in diameter; those more caudad smaller, on segment VI of 5-6 cells; no spinal or pleural glands except on tergite VII where 4-7 small (0.005 mm) cells are placed in a transverse row. Hind tarsal claws variable, 0.065-0.074 mm long, but vide discussion. Tarsi and about distal half of tibiae distinctly spinulose.

Discussion. Dr. M. Sorin late in 1968 sent me two more slides of *T. radicicola* Strand from *Ulmus* collected by S. Takagi and in these slides I found the present species which apparently has no name. The emigrants in nearly all respects agree with forma typica of *Tetraneura ulmi* (L.), but the last rostral segment is shorter, tergite VIII has more hairs, and the subanal plate has often only 4 instead of 6 hairs besides those on the gonapophyses. But these hairs in *T. sorini* differ so little from those on the gonapophyses that errors are hard to avoid. Embryos have a chaetotaxy very similar to that of embryonic *T. ulmi,* but the large hind tarsal claws and the completely different type of wax glands make confusion impossible. In the latter two characters there is agreement with *T. nigriabdominalis* Sasaki. But embryos of *T. nigriabdominalis* have at least 8 hairs on abd. tergites I-V instead of 6 hairs as in *T. sorini.* Besides in embryos of *T. nigriabdominalis* some of the ventro-lateral wax glands consist of two markedly different types of cells while those in *T. sorini* seem to be homogeneous.

Dr. Sorin also sent a slide with 4 emigrants from a somewhat globular petiolate gall from *Ulmus* sp., Kuroyama, Osaka, 26.V.'59, leg. M. Sorin, identified by R. Takahashi as *Tetraneura ulmi* L. The embryos

agree as to chaetotaxy with *T. sorini,* their ventro-lateral glands are of the same composition, only about half as large, with much smaller, uniform cells, but the hind tarsal claws measure about 0.048-0.060 mm. Besides, these claws are not much longer than those of the middle tarsi. The two complete alatae have the same number of antennal hairs, but with a much larger size of body the antennae are longer, with 16-23 rhinaria on segment III, 5-6 on IV, and 10-12 on V. I have not been able to decide whether this is also *T. sorini* or whether this is a different species of *Tetraneura.* For these specimens there are two entries in the key to the embryos, both leading to *T. sorini* spec. nov.

Two samples from *Ulmus* and, probably, two trapped sexuparae (fig. 10, 32, 50) from Korea probably belong here.

The new species is named after Dr. M. Sorin, Kogakkan University, Kuratayama, Ise-shi, Mie-ken, Japan, whose generous help made this study possible.

T y p e s. Holotype: alate viviparous female (no. 1 of measuments), emigrant from gall, *Ulmus* sp., Sapporo, Japan, 24.VI.'61, leg. S. Takagi. Paratypes: alate females with data as for holotype.

Further material : emigrants from gall on *Ulmus lacinata,* Seoul, Korea, 21.V.'68, leg. W.H. Paik no. 4589; emigrants from gall on *Ulmus* sp., Chochiwon, Korea, 30.V.'68, leg. W.H. Paik no. 4648.

Tetraneura ulmi (L., 1758)

Synonymy in Börner (1952), but not *Tetraneura yezoensis* Mats., 1917, and in addition:

1857. Koch, C.L., Pflanzenlaüse Aphiden: 313-314, *Endeis rorea* (misprint), Index: 233, *Endeis rosae* (misprint). Should be *Endeis rosea* according to all other authors.
1912. Dahl, F. Beitr. Naturdenkmalspflege, 3 : 435, *Tycheoides longisetosa.*
1950. Börner, C., Neue europäische Blattlausarten: 17, *Byrsocrypta personata.*

F u n d a t r i x.

Body globular, about 1.90-2.10 mm long, without wax glands, on abd. segments I-V with single, thin marginal hairs of 0.043-0.075 mm and similar pleural and spinal hairs; tergite VII with 4 hairs; tergite VIII with 2 hairs. Antennae of 3-4 segments, very often penultimate and ultimate only very partly separated. Last rostral segment short, 0.10 mm, triangular with slightly convex sides, with 4 hairs besides the 3 subapical pairs.

Measurements in mm.

No.	Length body	Ant.	Ant. segments	
			III	IV
1	1.94	0.22	0.12	0.05
2	1.99	0.28	0.13	0.06
3	1.92	0.27	0.12	0.06

(1-3, from *Ulmus campestris* var. *suberosa,* Grebbeberg, Netherlands, 19.VI.'32, leg. H.R.L.).

Alate viviparous female (emigrants from gall).

Body about 1.75-2.50 mm long. Head capsule with about 16-20 hairs of about 0.013-0.022 mm long, in forma *typica* without wax glands, in forma *personata* with 2 wax glands with central and peripheral cells of up to 0.036 mm diameter ventrad of the median ocellus, 2 smaller ones of up to 0.018 mm diameter on the front and irregularly 1, rarely 2 very small ones laterally on vertex. Antennae (fig. 34) short, about 1/3 length of body, with only distal part of segment V, and segment VI spinulose; segment I with 3 hairs; segment II with 2-4 hairs, normally 3 hairs; segment III rather thin with 3-8 hairs of about 0.015 mm long and with 8-17 rhinaria most of which encircle half the segment; segment IV with 2-6 hairs and 2-4 rhinaria; segment V with 7-10 hairs and 5-8 rhinaria, the most basal one rather far from base; primary rhinarium on VI very irregular, branched; processus terminalis thick, about 1/5 of the length of the segment. Last rostral segment about 0.11-0.13 mm long with 6-10 hairs in forma *typica,* 0.13-0.15 mm with 6-8 hairs in forma *personata,* 2/3-4/5 of the second joint of hind tarsi. Wax glands on thorax and abdomen absent in forma *typica*; present in forma *personata* on abdomen in the way as in apterous exules, but mostly slightly smaller. Legs variable; dorsal hairs halfway hind tibiae adpressed, 0.013-0.022 mm long. Siphunculi absent in forma *typica,* present but variable in size in forma *personata.* Abd. tergite VIII with usually 4 hairs (2 long, 2 short) informa *typica,* with 2 long hairs in forma *personata.* Cauda with 2, rarely 3 hairs. Subanal plate with 6 long hairs and a number of hairs on the gonapophyses.

Measurements in mm.

No.	Length body	Ant.	Antennal segments				Rhin. on segments		
			III	IV	V	VI	III	IV	V
1	2.17	0.73	0.27	0.10	0.16	0.11	14 & 16	3 & 3	6 & 6
2	2.12	0.72	0.27	0.10	0.16	0.10	13 & 16	3 & 3	6 & 6
3	1.85	0.61	0.22	0.07	0.14	0.10	12 & 14	2 & 2	6 & 5
4	1.92	0.56	0.20	0.07	0.12	0.10	12 & 14	2 & 3	6 & 7
5	2.04	0.61	0.21	0.07	0.13	0.10	13 & 14	3 & 4	6 & 7
6	2.23	0.67	0.24	0.09	0.14	0.10	14 & 15	2 & 2	5 & 5
7	2.09	0.67	0.24	0.06	0.14	0.09	14 & 14	3 & 3	5 & 6
8	1.80	0.57	0.18	0.07	0.14	0.09	8 & 11	2 & 2	5 & 6
9	2.13	0.63	0.23	0.10	0.13	0.09	11 & 12	3 & 3	5 & 5

(1-2, from *Ulmus campestris* var. *suberosa,* Grebbeberg, Netherlands, 19.VI.'32, leg. H.R.L.; 3-5, from *Ulmus campestris* cultivar « Christine Buisman », Kew Gardens, London, England, 7.VII.'63, leg. V.F. Eastop no. 9576a; 6-7, like 3-5, but no. 9577b; 8-9, *Ulmus* sp., Hessarak, Iran, 17.VI.'55, leg. G. Remaudière i. 541 (3). No. 1-5 are forma *typica,* no. 6-9 forma *personata*).

Apterous viviparous female (exules).

Body 1.90-2.65 mm long. Dorsal hairs on thorax to abd. tergite V usually all very short (0.013-0.022 mm long), sparse, with on tergite VIII 2 very stout hairs of about 0.17 mm; similar, but shorter stout hairs may laterally, and rarely spinally, occur on several more anterior tergites getting shorter cephalad, and if they occur such hairs may get very abnormal shapes; large types of hairs always in single pairs spinally and marginally per segment. Antennae of 5, rarely 6 segments, 1/6-1/5 of length of body, smooth or with a few spinules on last segment; segment I with 3 hairs of 0.008-0.013 mm long, II with 3 hairs, III in specimens with 6 segments with 1-2 hairs; and then IV with 2-4 hairs, but III in specimens with 5 segments with 1-4 hairs; penultimate segment with 8-12 hairs. Last rostral segment about 0.19-0.22 mm long, with normally 12, sometimes 10 hairs besides the 3 subapical pairs. Wax glands in principle consisting of a round to oval central cell surrounded by a single or partly double layer of small cells; only ventro-laterally on tergites VII and VI glands always fully developed, with oval to round, rarely subdivided central cells of 0.020-0.060 mm maximum length, and with small cells with their long axes at right angles to the central cells; but cephalad the glands smaller, with flatter and flatter peripheral cells, till especially spinally peripheral cells may completely disappear. Tibiae rather cylindrical, comparatively thin, e.g., 0.055 mm in the middle; hind tarsi about 0.075-0.080 mm long. Tergite VIII with 2 hairs. Cauda with 2 hairs. Subanal plate with 6 hairs besides those on the rudimentary gonapophyses.

Body in life very variable in colour, not as stated by ZWÖLFER (1957) red in spring, more yellow in late summer, but light pink, deep purple or yellowish in the same clone at all times of the season.

Measurements in mm.

No.	Length body	Ant.	Antennal segments		
			III	IV	V
1	2.57	0.40	0.10	0.13	0.07
2	2.38	0.40	0.11	0.13	0.06
3	2.09	0.43	0.10	0.15	0.09
4	2.21	0.44	0.09	0.15	0.09
5	2.53	0.40	0.09	0.14	0.06
6	2.21	0.38	0.07	0.13	0.06
7	1.92	0.38	0.07	0.13	0.07
8	2.55	0.41	0.07	0.15	0.09
9	2.47	0.45	0.10	0.14	0.07
10	2.11	0.43	0.09	0.13	0.07

(1-2, from *Agropyron repens,* Arnhem, Netherlands, 24.V.'63, leg. H.J. de Groot; 3-4, from *Deschampsia flexuosa,* Bennekom, 10.VI.'44, leg. H.R.L.; 5-6, from *Zea mays,* Belgrade, Yougoslavia, 17.VII.'56, leg. Stankovic; 7, sieved from soil, Isola Estela, Bajona, Spain, 2.VIII.'56, leg. H. Franz; 8, from *Hordeum murinum,* Karaj, Iran, 15.V.'55, leg. G. Remaudière, i 266; 9-10, lectocotypes of *Pemphigus boyeri* Passerini).

Alate viviparous female (virginoparous exules and sexuparae).

In many respects like forma *personata* of emigrants from galls. However, ant. segments (fig. 35) III and IV sometimes completely fused, penultimate segment with 7-13 rhinaria, and 2-3 1/5 times as long as last segment. Last rostral segment much longer, 0.18-0.20 mm, and about 1 1/4 1 1/3 times as long as second joint of hind tarsi, with 6-8 hairs besides the 3 subapical pairs. Wax glands on abdomen variable, on abd. segment VII marginally sometimes with double layers of peripheral cells and subdivided central cells; only rarely spinal wax glands of anterior tergites with a complete ring of peripheral cells, sometimes without peripheral cells. Siphunculi present. Chaetotaxy of abd. tergite VIII, cauda and subanal plate as in forma *personata* of emigrants.

Measurements in mm.

No.	Length body	Ant.	Antennal segments				Rhin. on segments		
			III	IV	V	VI	III	IV	V
1	2.15	0.69	0.22	0.09	0.21	0.07	13 & 14	3 & 2	10 & 10
2	2.21	0.67	0.21	0.06	0.19	0.09	14 & 15	2 & 2	7 & 8
3	2.30	0.79	0.28	0.08	0.21	0.10	14 & 14	3 & 3	11 & 12
4	2.27	0.83	0.30	0.10	0.23	0.07	14 & ?	4 & ?	13 & ?
5	2.30	0.64	0.28	0.18	0.09		16 & 17	9 & 7	

(1, from yellow trap, Rehovot, Israel, 25.IX-2.X.'54, leg. S. Zimmermann; 2, from yellow trap, Escuminac (N.Br.), Canada, IX.'56, leg. M.E. McGillivray; 3, resting on tobacco, Alliston (Ont.), Canada, 13.IX.'67, leg. J. Sijpkens; 4, from *Poa annua,* Bennekom, Netherlands, 14.IX.'63, leg. H.R.L.; 5, from *Deschampsia flexuosa,* Bennekom, Netherlands, 14.IX.'46, leg. H.R.L.; 1-3, virginoparous exules, 4-5, sexuparae).

Embryo taken from emigrant, or larvae I (fig. 55).

Antennae (fig. 45) of 5 segments, with segments IV and V completely spinulose; segment I with 3 long (0.060 mm) hairs and one short one; II with 2 long hairs; III without hairs, IV with 8-11 long hairs; primary rhinaria on V with 3 horns. Last rostral segment 0.14-0.15 mm long, with 8 lateral hairs besides the 3 subapical pairs. Hairs on abd. tergites I-V rather constant; each of segments I-V with 1 pair of marginal hairs, pleural hairs and rather long spinal hairs, of which the marginal hairs are the longest, 0.045-0.120 mm, the pleural ones always short, 0.012-0.028 mm, the spinal ones shorter than the marginal ones, 0.012-0.110 mm, with great variation in length of marginal and spinal hairs between galls; tergite VII with 4 long hairs, tergite VIII with 2 long hairs. Wax glands (fig. 21) of the same type as in exules, but the peripheral cells very narrow and spinally mostly absent, the central cells ventro-laterally usually crenulated or vaguely subdivided; ventro-lateral central cells on segment VII very elongated, almost linear. Hind tarsal claws 0.030-0.038 mm long. Tarsi and distal 3/4-4/5 of tibiae markedly spinulose (fig. 7).

Embryos taken from exules.

As embryos from emigrants, but marginal, pleural and spinal hairs on the 5 anterior abd. segments generally much shorter and often stouter, bent or with abnormal apices; pleural hairs apparently sometimes absent. Antennal hairs in long-haired specimens to 0.087 mm long, but in short-haired ones less than half as long.

Discussion. I have little to add to the excellent study made by ZWÖLFER (1957) of this aphid. He worked out the chaetotaxy of the embryos of first instar larvae and found that pleural hairs may be absent or present, very short to rather long, that there is a very great variation in the length of the anterior spinal hairs within clones and between clones, and that there is no gap between *T. ulmi* and the form BÖRNER called *T. longisetosa* Dahl in this respect. The latter is a form with very long hairs, according to ZWÖLFER associated with moist or shadowy biotopes, and often found without ants. I have not seen specimens with hairs as long as mentioned by ZWÖLFER for typical *longisetosa* from grass roots. As ZWÖLFER mentions no other differences between *ulmi* and *longisetosa* than the length of the dorsal hairs and a very dubious difference in the structure of the marginal wax glands on abdominal tergite VII, I am not convinced that *T. longisetosa* Dahl, 1912 as revived by BÖRNER (1952) and ZWÖLFER (1957) really is a good species. It is remarkable that ZWÖLFER (1957, p. 549) mentions one population of *longisetosa* in which first instar larvae showed many more than 6 dorsal hairs. One wonders whether perhaps another species was involved.

BÖRNER (1952) and ZWÖLFER (1957) quote about the same synonyms of *T. ulmi*, but Zwölfer also lists *personata* Börner, 1950 and *rosea* Koch, 1857 which BÖRNER (1952) treats as different species. *T. personata* is discussed in the Introduction on p. 23. *T. ulmisacculi* Patch, 1910 probably was introduced into North America. American alate virginoparae do not differ from European ones, and it is interesting to notice that *Tetraneura ulmisacculi* would preoccupy *T. personata* (Börner) if that were a species. The identity of *Pemphigus boyeri* Pass., 1856 with *T. ulmi* I can confirm, after Dr. Stroyan and I remounted some of the original Passerini material of *boyeri*. *Tetraneura yezoensis* Mats., 1917, which by MORDVILKO (1935), BÖRNER (1952) and ZWÖLFER (1957) was listed as a synonym, certainly is not the same as *T. ulmi*. The most Eastern material of *T. ulmi* that I saw came from Iran. Records from Japan, China, Indonesia, etc., probably relate to other species.

ZWÖLFER comments on the scarcity of sexuparae produced in the autunn in colonies on grass roots, which I can confirm. He does not mention that in the autumn sometimes virginoparous alatae are produced without any secondary rhinaria, but otherwise normal. Colonies of overwintered exules have been found in which in June most of the nymphs became alate and virginoparous.

Types. No type material of *Aphis ulmi* L. is known. Cotypes of *Pemphigus boyeri* Pass. in Zool. Inst., Parma, Italy and the collections of H.L.G. Stroyan, Harpenden, England and myself. Types of *Byrsocrypta personata* Börner in Deutsches Entom. Instit., Eberswalde, East Germany. Types of other synonyms probably non existent.

Tetraneura yezoensis Matsumura, 1917

1917. Matsumura, S., A collection of essays for Mr. Yasushi Nawa, 3 : 73-74, *Tetraneura yezoensis.*
1961. Carver, M. & Basu, A.N., Proc. R. Ent. Soc. Lond. (B), 30 : 83-84, *Tetraneura heterohirsuta* partim.

Fundatrix.

Body roundish, about 1.40-1.65 mm long, without wax glands, on abd. segments I-V with single, stiff, fine, dark marginal hairs of about 0.105-0.120 mm long and about 8-10 hairs of 0.050-0.075 mm in between; but in total 4-6 hairs on tergite VII and 2 on tergite VIII. Cauda with 2 hairs. Subanal plate with 4 hairs besides those on the gonapophyses. Front of head with hairs of up to 0.090 mm. Antennae of 3 segments, but mostly with an incomplete division in the IIIrd so that real 4-segmented antennae may occur. Last rostral segment 0.090-0.095 mm, with only 4 hairs besides the 3 subapical pairs.

Measurements in mm.

No.	Length body	Ant.	Ant. segments	
			III	IV
1	1.52	0.22	0.10	0.04
2	1.62	0.23	0.10	0.05
3	1.61	0.23	0.11	0.06
4	1.47	0.26	0.17	

(vide next morph; 1, from gall 514; 2, from 517; 3, from 516; 4, from 525).

Alate viviparous female (emigrants from gall).

Body about 1.85-2.10 mm long. Head capsule with about 36-40 hairs of up to 0.65 mm long, without wax glands. Antennae (fig. 37) about 1/3 of length of body, with at least segments V and VI distinctly spinulose, but often also segment IV faintly spinulose; segment I with 2 long hairs of 0.030 mm and one short hair; segment II with 3-4, rarely 7 hairs (one specimen with 7 on left, 3 on right segment!); segment III

with 9-17 rhinaria, some of which may encircle 4/5 of the segment; segment IV with 2-5 rhinaria; segment V with 9-11 rhinaria; primary rhinarium on VI irregular in shape, but not very branched. Last rostral segment about 0.09-0.11 mm long, with 6-8 hairs besides the 3 subapical pairs, 5/7 - 5/6 of second joint of hind tarsi. Wax glands seemingly absent, but on abd. segments I-VII ventro-marginally present as single, rarely double and 8-shaped, round cells of 0.008-0.009 mm diameter with a pale brown sclerotic ring. Legs rather thick; dorsal hairs halfway the hind tibiae 0.034-0.039 mm long. Wings with the pterostigma almost evenly dark. Siphunculi always (?) present, blackish, about 0.013 mm long, at apex 1½ times as wide (0.030 mm) as at base. Cauda with 2, rarely 3 hairs. Subanal plate with 6-8 hairs besides the hairs on the gonapophyses.

Measurements in mm.

No.	Length body	Ant.	Antennal segments				Rhin. on segments		
			III	IV	V	VI	III	IV	V
1	1.94	0.60	0.19	0.06	0.15	0.07	13 & 14	3 & 3	11 & 8
2	1.88	0.62	0.19	0.07	0.16	0.07	13 & 14	4 & 5	10 & 11
3	2.01	0.61	0.18	0.07	0.16	0.07	9 & 10	3 & 4	8 & 10
4	2.02	0.62	0.19	0.09	0.16	0.07	10 & 10	2 & 4	8 & 9
5	1.94	0.68	0.22	0.09	0.17	0.10	11 & 11	3 & 4	8 & 6
6	2.09	0.65	0.23	0.07	0.16	0.10	15 & 17	3 & 3	10 & 8
7	1.91	0.62	0.22	0.09	0.16	0.09	12 & 14	3 & 4	10 & 10
8	1.90	0.68	0.23	0.09	0.17	0.09	13 & 16	4 & 5	9 & 11

(All from *Ulmus davidiana* var. *japonica,* Sapporo, Japan, 4.VII.'66, leg. M. Sorin; 1-2, from gall 514; 3-4, from gall 517; 5-6, from gall 516; 7-8, from gall 525).

Apterous viviparous female (exules).

Body about 2.00-2.40 mm long. Dorsum rather evenly covered with uniform hairs with extremely fine apical parts, seemingly about 0.020 mm long, but actually about 0.09 or 0.10 mm long, on abd. tergite II density about 10-12 per 0.1x 0.1 mm^2; from tergites III or IV to VII one hair in the marginal hairgroup very much stouter, 0.22 mm long or longer, and also often some of these tergites from VII cephalad with a pair or half a pair of similar spinal hairs; tergite VII with 2 large marginal hairs, 12-16 fine marginal hairs, 2 large spinal hairs and 2-6 fine spinal and pleural hairs; tergite VIII with 2 large spinal hairs and between these 2 smaller hairs. Antennae of 5 segments; segment I with 5-6 hairs like those on dorsum and one short (0.015 mm) hair; segment II with 9-14 hairs; III with 16-21 hairs; IV with 18-27 hairs; base of V with 2-3 long hairs and one short one. Last rostral segment very stout, 0.22 mm long,

with 16-18 hairs besides the 3 subapical pairs. Wax glands oval or round, consisting of a single cell with often crenulated rim without minute cells against the periphery; surface of cell stippled, not subdivided; ventro-lateral glands rather uniform in size, all about 0.030 mm in diameter; spinal and pleural glands smaller, 0.009-0.006 mm in diameter. Tibiae rather slender, about 0.060 mm; hind tarsal joints 0.085-0.090 mm long. Cauda with 2-3 hairs. Subanal plate with 8 stout hairs besides those on the gonapophyses.

Measurements in mm.

No.	Length body	Ant.	Antennal segments		
			III	IV	V
1	2.13	0.44	0.10	0.15	0.065
2	2.09	0.49	0.10	0.16	0.065
3	2.27	0.46	0.11	0.16	0.065

(1-3, from *Pennisetum clandestinum,* Moree, N.S.W., Australia, 1.X.'51, leg. A.L. Dyce [paratype of *T. heterohirsuta* Carver & Basu]).

Alate viviparous female (virginoparous exul).

Body about 1.90-2.70 mm long. Head capsule with about 55-65 very fine hairs, with ventral wax glands 0.021-0.035 mm in diameter and sometimes small frontal wax glands. Ant. segment I with 3-6 long hairs; segment II with 11-15 hairs; segment III with 12-20 hairs and 9-14 rhinaria; segment IV with 6-11 hairs and 3-5 rhinaria; segment V with 19-32 hairs and 7-12 rhinaria. Last rostral segment 0.19-0.23 mm long, with 14-21 hairs besides the 3 subapical pairs, about 1½ times as long as second joint of hind tarsi. Wax glands on abdomen distinct, the ventro-lateral ones consisting of one slightly stippled, undivided cell, in one specimen with one gland of 3 cells. Legs very hairy; tibiae thinnest on distal 1/3 part, distad thicker; hind tibia dorsally in its middle with fine hairs of up to 0.060 mm long. Tergites I-V with great numbers of fine marginal hairs; tergites III or IV to VII with one pair of very much stouter marginal hairs of up to 0.15 mm long, and spinally similar hairs usually present on tergites VII and VIII; tergite VIII with 2-4 hairs. Cauda with 2-3 hairs. Subanal plate with 8 long hairs.

Measurements in mm.

No.	Length body	Ant.	Antennal segments				Rhin. on segments		
			III	IV	V	VI	III	IV	V
1	2.55	0.71	0.21	0.09	0.22	0.06	14 & ?	3 & ?	12 & ?
2	1.95	0.65	0.20	0.07	0.19	0.06	13 & 13	4 & 5	10 & 10
3	2.30	0.60	0.16	0.09	0.19	0.05	9 & 9	3 & 3	7 & 9

(1-2, from yellow trap, Brisbane, Australia, V-IX.'62, leg. R. D. Hughes, B. M. no. 1962-16; 3, from trap on ship near Tokara Islands, Japan, 18-28.III.'60, leg. J. L. Cressik, B.M. no. 796/62).

First instar larvae of fundatrix (from cast skin) (figs. 48a-c).

Black, and whole body solidly sclerotic. Antennae of 5 segments with segment III twice as wide as long; hairs about 0.024-0.030 mm long, stiff with incrassate apices, but one hair, on basal half of last segment, 0.061 mm long, blunt, cylindrical. Last rostral segment slender, 0.11 mm long. Dorsal hairs probably 8 (2 marginal pairs) per segment on abd. tergites I-V, about 0.020-0.028 mm long, all with swollen apices. Stigmata very large. No wax glands present. Legs black sclerotic, tarsi quite smooth, ventrally with 2 long hairs of 0.060 mm and 2 short hairs of 0.013 mm, dorso-apically with two long (0.070 mm) curved, thick hairs with swollen apices that are very similar to the empodial hairs of 0.045 mm long.

Embryos taken from emigrant.

Antennae of 5 segments with segments IV and V completely spinulose, segment IV ± 2½ times as long as V; segment I with 2-3 hairs of 0.085 mm and one short (0.009 mm) hair; II with 3-4 long hairs, III with 2 long hairs, IV with about 16-20 long hairs. Last rostral segment 0.175 mm long, with 10-14 hairs besides the 3 subapical pairs. Abd. segments I-V with groups of 3-6 long marginal hairs of which the longest is about 0.17 mm, the shortest 0.055 mm; between these marginal groups mostly 8, sometimes 10 long spinal and pleural hairs; tergite VII with 4 hairs; tergite VIII with 2 hairs. Cauda with 2 hairs. Subanal plate with 6-8 hairs. Wax glands very distinct, the ventro-lateral ones round to oval with a crenulated margin and an evenly stippled surface; scattered around the margin a few very small, mostly flattened cells; the largest of these glands, on pronotum, 0.043 x 0.016 mm; the smallest, on abd. tergite V, about 0.010 mm; spinal and pleural glands about 0.004-0.007 mm in diameter, consisting of single, double or triple small cells. Hind tarsal claws 0.043-0.047 mm long. Tarsi and at least distal half of the tibiae markedly spinulose.

Embryos taken from exules.

Antennae of 5 segments, with segments IV and V spinulose and probably also III with a few spinules; segment I with 5-6 long (0.070-0.075) hairs and one short one; II with 7-8 hairs; III with 4-5 hairs; IV with 20-23 hairs; V with 2 long hairs and a 3-branched rhinarial membrane of which the median one is much longer than the lateral ones. Last rostral segment (not stretched) 0.175 mm, with some 16 hairs besides the 3 subapical pairs. Abd. tergites I-V with marginal hairs in groups of 5-8 hairs of about 0.080-0.090 mm long, but on tergites IV-VII one of the hairs conspicuously stouter and about 0.130-0.150 mm long; between the marginal groups 12-20 spinal and pleural hairs present, not in a single row; of the latter 2 hairs on tergites IV-VII, but vaguely also on III, are longer and much thicker than the others; tergite VII with 12 hairs: 6 marginally, 6 spinally and pleurally. Tergite VIII with 3-4 hairs. Cauda with 2 hairs. Subanal plate with 8 stout hairs. Wax glands as in other embryos. Hind tarsal claws 0.039 mm long. Tarsi and at least distal half of tibiae markedly spinulose.

Discussion. In 1967 I published that *T. radicicola* Strand might be the same as *T. yezoensis* Mats. This suggestion was based on a slide with two emigrants from *Ulmus davidiana* var. *japonica* collected by S. Takagi, and on a number of emigrants from galls on that host tree that had been sent by Dr. M. Sorin. These galls agreed with the description given for *yezoensis* galls by MATSUMURA (1917).

Since then the specimens in this and similar Takagi slides were remounted and the embryos taken out of some of the emigrants, embryos were taken from Australian (leg. Dyce) and Indian paratypes of *T. heterohirsuta* Carver & Basu, and two first instar larvae of *T. radicicola* Strand from Kepong, Malaya, and Assam, India, were obtained.

It appears that I overestimated the variability of the chaetotaxy of embryos of *T. yezoensis* emigrants from *Ulmus* galls. The specimens collected by Takagi contained embryos that agreed unmistakably with the larva I of *radicicola* from Kepong, and therefore *T. radicicola* Strand overwinters as eggs, and makes galls on *Ulmus davidiana* var. *japonica* in Japan. But the embryos from emigrants from *yezoensis* galls have fewer antennal and abdominal marginal hairs, though quite the same type of wax glands and last rostral segment. They showed very little variability in this respect when inhabitants from 12 galls were dissected. They come nearer the embryos inside Australian (leg. Dyce) paratypes of *T. heterohirsuta* Carver

& Basu, but the latter still had too many hairs. EASTOP (1966) pointed out that Australian paratypes, apterous exules, differ in number of hairs from the Indian type material of the latter species. He found similar differences among trapped alatae. He most kindly allowed me to examine these alatae. These fall into two categories: A., specimens with about 11-15 hairs on antennal segment II, 19-32 hairs on V and 14-21 (+ 6) hairs on the last rostral segment; and B., specimens with 18-24 (abnormally 15) hairs on II, 37-65 hairs on V, and 24-33 (+ 6) hairs on the last rostral segment.

The B. specimens contain embryos that agree quite well with those taken from the Takagi specimens, and they are elsewhere described in this paper as *T. radicicola* Strand.

The A. specimens, two from Australia and one trapped south of Japan, are virginoparae. Their embryos have fewer hairs than those in the Australian paratypes of *T. heterohirsuta* Carver & Basu, but about the same number as embryos taken from *T. yezoensis* emigrants from galls. And though the adult Australian alatae differ in very many respects, such as chaetotaxy of antennae, last rostral segment, etc., from emigrants from galls of *yezoensis,* their embryos are strikingly similar. It is indeed hard to believe how different in relevant taxonomic characters the emigrant's embryos are from their mother.

Unless the measured Australian alatae are not conspecific with the Australian paratypes of *heterohirsuta,* these specimens must be part of the cyclus of *Tetraneura yezoensis* Mats. from *Ulmus davidiana* var. *japonica.* Therefore I have described the mentioned apterae, and the alate virginoparous A. exules as *T. yezoensis.*

T. yezoensis differs on its primary host from *T. radicicola* by the presence of siphunculi, but one should remember the *personata* theory of Zwölfer discussed on p. 23 of this paper. The embryos differ only in hairiness, and also in this respect there is a warning in ZWÖLFER's (1957) paper, who writes that he saw embryos of *T. longisetosa* Dahl with multiple transverse rows of dorsal hairs instead of the normal single transverse row.

The same type of chaetotaxy and of wax glands is encountered in embryos of *T. polychaeta* spec. nov., but that species does not belong to this complex because the embryonic claws are enlarged and the tarsi smooth instead of spinulose.

MORDVILKO (1935) wrote that *T. yezoensis* Mats. is a synonym of *T. ulmi* (L.), but they belong to different groups of the genus. MONZEN (1929) gave a description of what he calls *Tetraneura yezoensis* Mats., but

he described the galls as being covered with many hairs, and therefore he had *T. fusiformis* Mats. (or *nigriabdominalis* Sasaki) from *Ulmus davidiana* var *japonica*. The same author described *Tetraneura akinire* Sasaki from *Ulmus japonica* as having smooth galls, and this evidently was *T. yezoensis* Mats. However, he credits the emigrants with siphunculi, but as he also described siphunculi in fundatrices and emigrants of his *yezoensis* (= *fusiformis* Mats.), I am reluctant to believe this observation.

Types. Those of *Tetraneura yezoensis* Mats. almost certainly lost. Australian paratypes of *T. heterohirsuta* in State Agric. Res. Inst., Calcutta, India, C.S.I.R.O., Canberra, Australia, Brit. Mus (Nat. Hist.), London, and the author's collection.

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XII. References in the Discussion.

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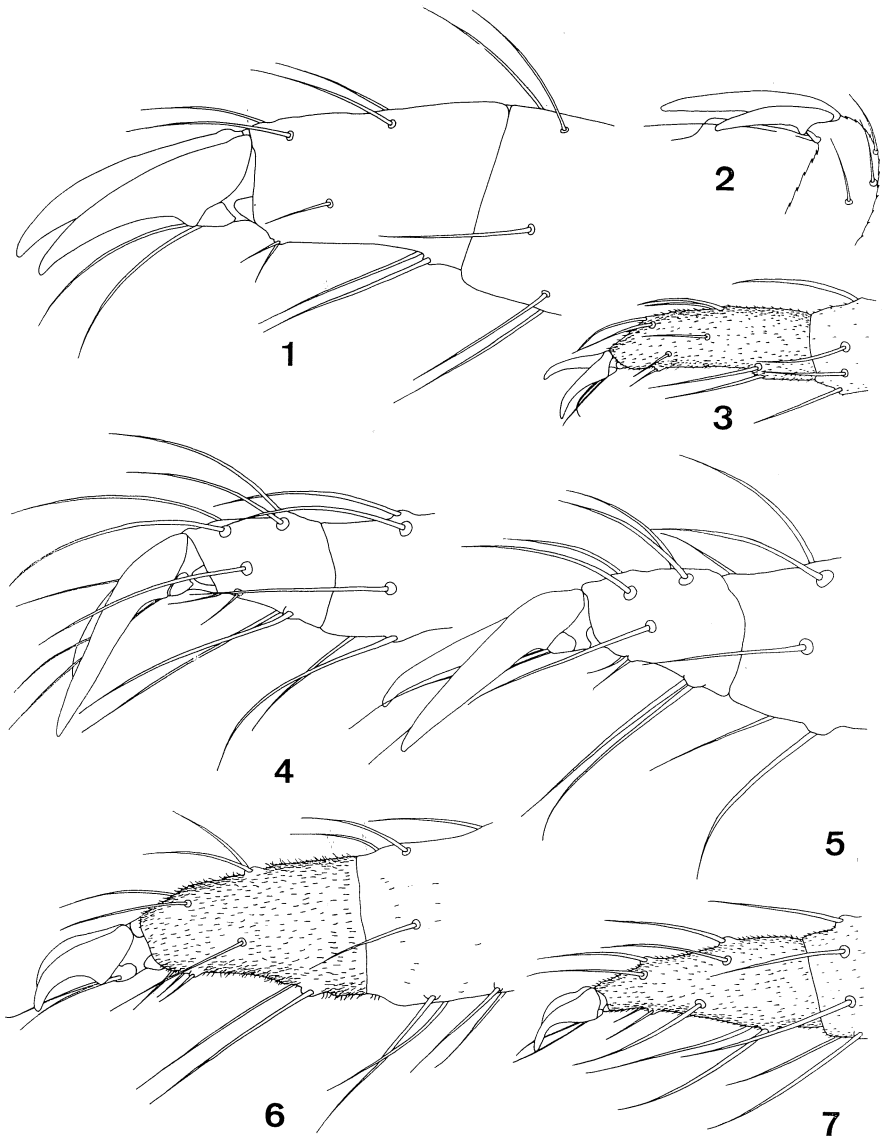
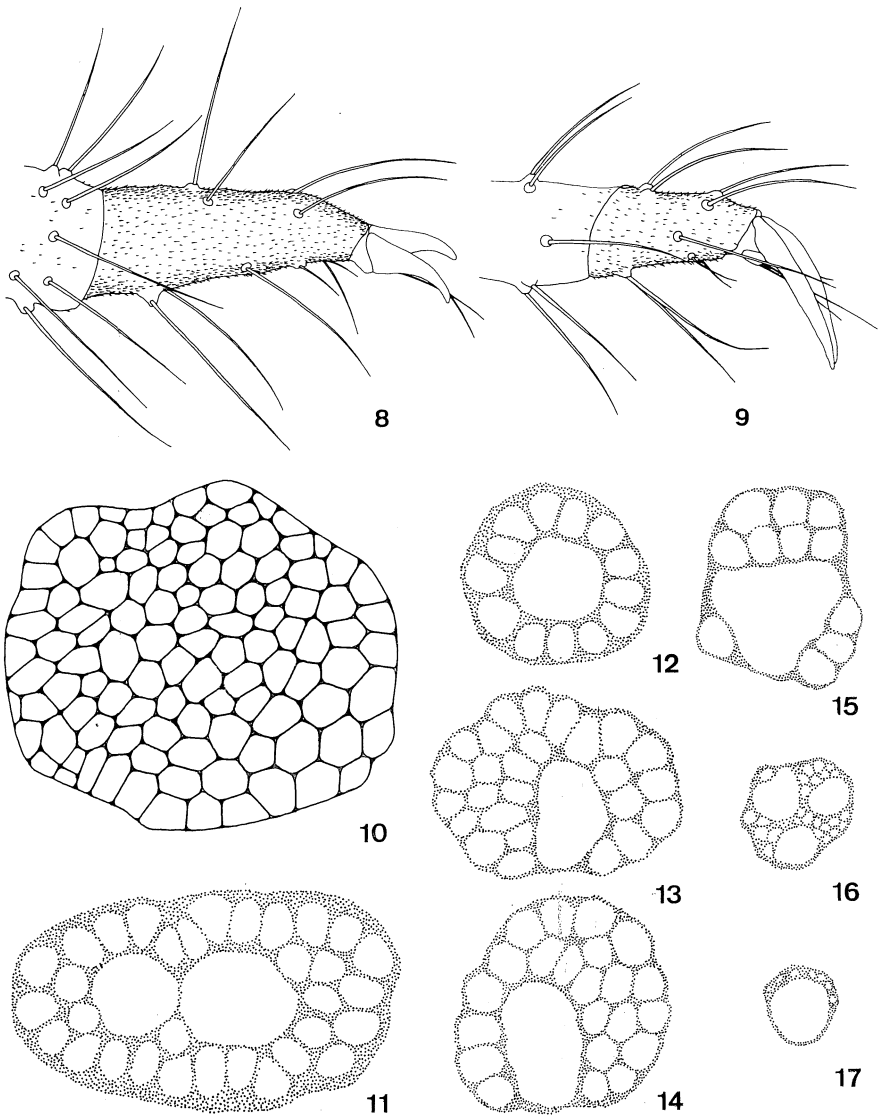
EXPLANATION OF FIGURES

Plate I.



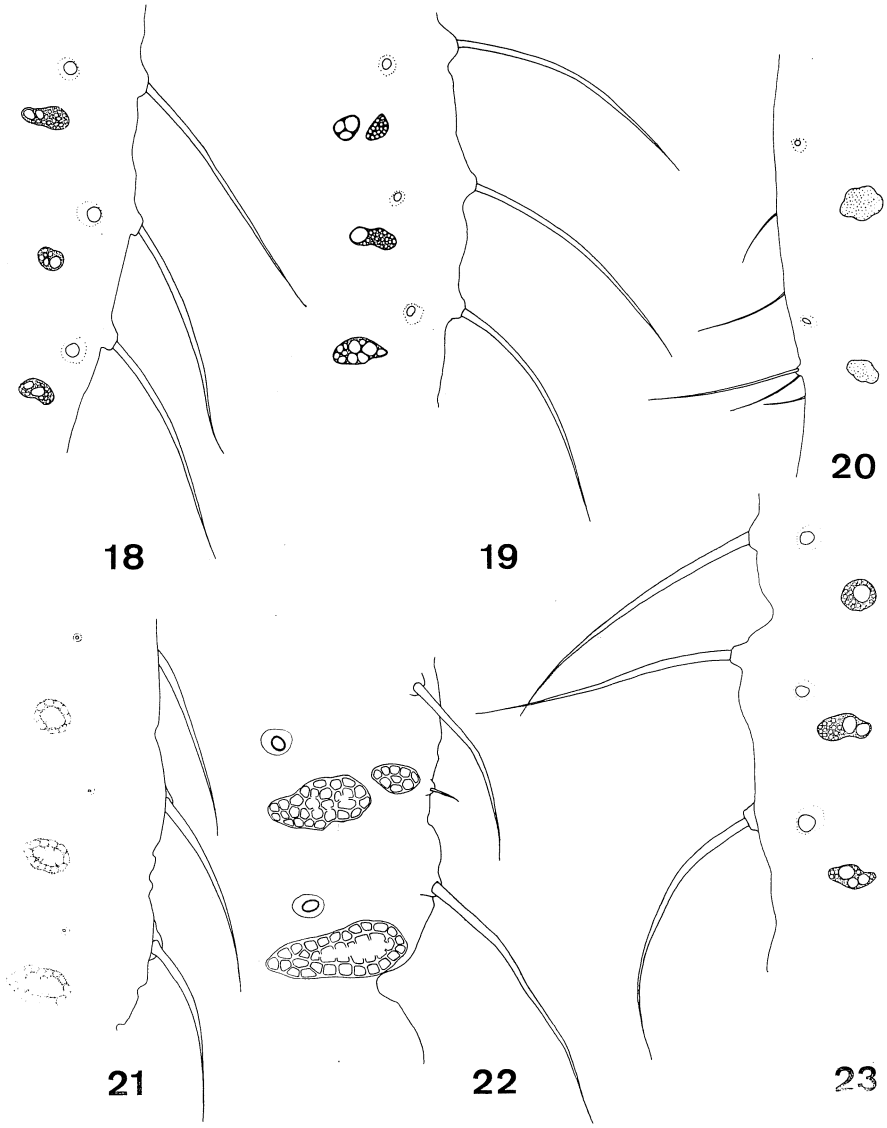
Hind tarsus and claws of: 1. *T. polychaeta* spec. nov., larva I, 3rd gen., Pakistan; 2. *T. javensis* v.d. Goot, embryo from emigrant, Pakistan; 3. *T. caerulescens* Pass., larva I, 3rd gen., France; 4. *T. akinire* Sasaki, larva I, 3rd gen., Japan; 5. *T. akinire* Sasaki, larva I from grass roots, Italy; 6. *T. africana* v.d. Goot, larva I from grass roots, Iran; 7. *T. ulmi* L., larva I, 3rd gen., Netherlands, All x 330.

Plate II.



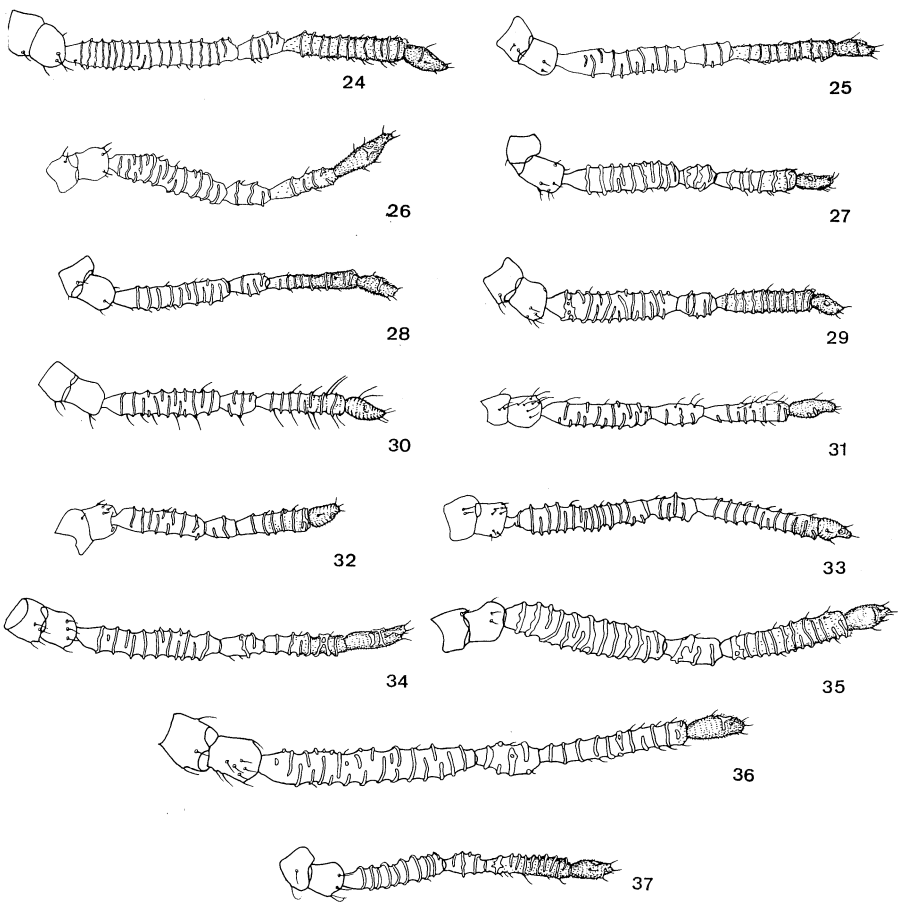
Hind tarsus and claws of larvae I of: 8. *T. radicicola* Strand, from grass roots, Malaya; 9. *T. nigriabdominalis bispina* subspec. nov., from grass roots, Kenya. All x 290. Marginal wax gland of sexupara of: 10. *T. sorini* spec. nov., Korea. Ventro-lateral wax glands of adult apterous exules of: 11-12. *T. caerulescens* Pass., France; 13-15. *T. javensis* v.d. Goot, India; 16. *T. basui* spec. nov., India. Pleural wax gland of adult exul of: 17. *T. basui* spec. nov., India. All x 500.

Plate III.



Ventro-lateral wax glands of abdomen of larvae I of: 18. *T. akinire* Sasaki, 3rd gen., Japan; 19. *T. akinire* Sasaki, from grass roots, Italy; 20. *T. radicicola* Strand, from grass roots, Malaya; 21. *T. ulmi* L., 3rd gen., Netherlands; 22. *T. africana* v.d. Goot, from grass roots, Iran; 23. *T. nigriabdominalis bispina* subspec. nov., from grass roots, Kenya. All x 350.

Plate IV.



Antennae of alatae of: 24. *T. akinire* Sasaki, sexupara, Korea; 25. *T. akinire* Sasaki, emigrant, Japan; 26. *T. caerulescens* Pass., emigrant, Frnce; 27. *T. javensis* v.d. Goot, emigrant, Pakistan; 28. *T. nigriabdominalis* Sasaki, emigrant, Japan; 29. *T. nigriabdominalis* Sasaki, sexupara, Japan; 30. *T. paiki* spec. nov., sexupara, Korea; 31. *T. radicicola* Strand, emigrant, Japan; 32. *T. sorini* spec. nov., emigrant, Japan; 33. *T. sorini* spec. nov., sexupara, Japan; 34. *T. ulmi* L., emigrant, Netherlands; 35. *T. ulmi* L., sexupara, Netherlands; 36. *T. polychaeta* spec. nov., emigrant, Pakistan; 37. *T. yezoensis* Mats., emigrant, Japan. All x 74.

Plate V.

Antennae of larvae I of: 38. *T. africana* v.d. Goot, from grass roots, Iran; 39. *T. akinire* Sasaki, from grass roots, Japan; 40. *T. akinire* Sasaki, from grass roots, Italy; 41. *T. caerulescens* Pass., from grass roots, France; 42. *T. nigriabdominalis bispina* subspec. nov., from grass roots, Kenya; 43. *T. radicicola* Strand, from grass roots, Kepong; 44. *T. polychaeta* spec. nov., 3rd gen., Pakistan; 45. *T. ulmi* L., 3rd gen., Netherlands. 46. *T. basui* spec. nov., antenna of apterous exul, India. All x 100. 47. *T. nigriabdominalis* Sasaki, larva I of fundatrix, Japan: a) hind leg, b) antenna, x 100; c) apex of antenna, x 475. 48. *T. yezoensis* Mats., larva I of fundatrix, Japan: a) hind leg, b) antenna, x 100; c) apex of antenna, x 475. 49. *T. javensis* v.d. Goot, embryo from emigrant, Pakistan, apex of antenna, x 475. 50. *T. sorini* spec. nov., sexupara, Korea, caudal segments, x 100. 51. *T. akinire* Sasaki, sexupara, Korea, caudal segments, x 100.

Plate V.

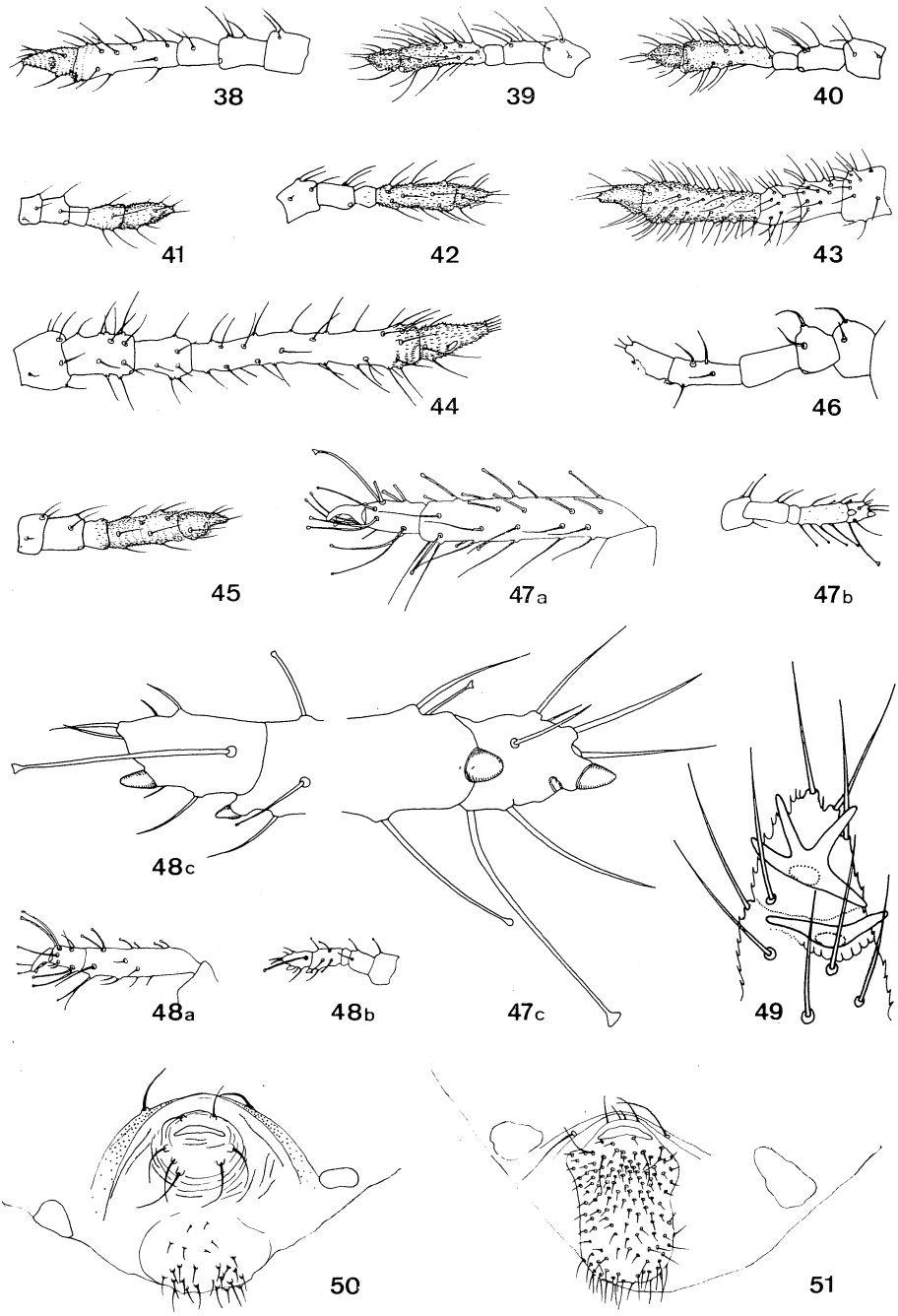
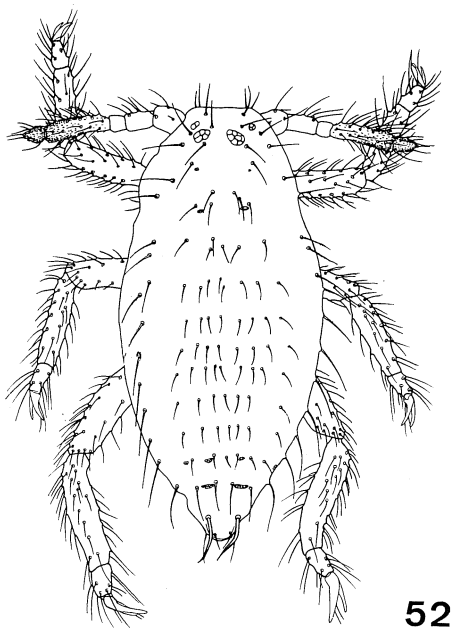
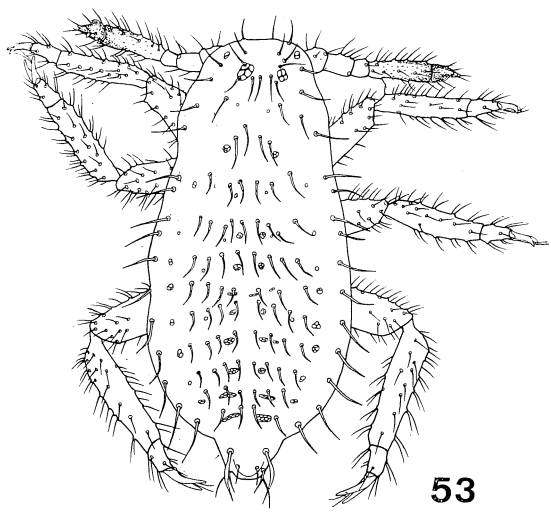


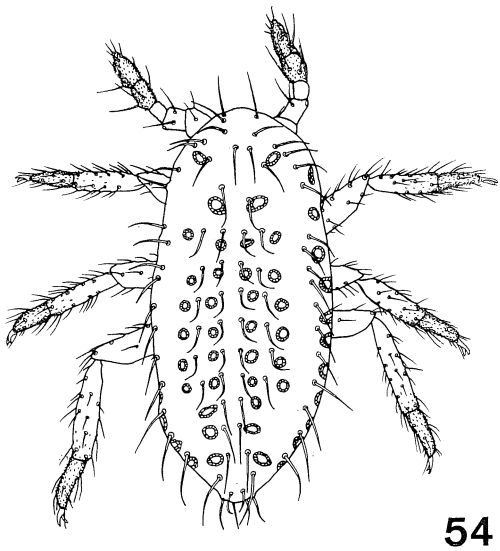
Plate VI.



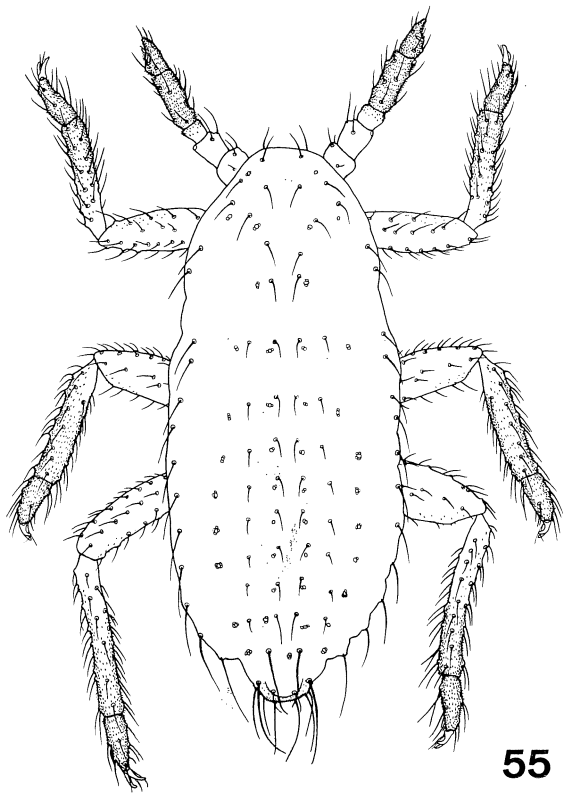


T. akinire Sasaki, larvae I: 52. 3rd gen. from Japan; 53. from grass roots. Italy, x 73.

Plate VII.



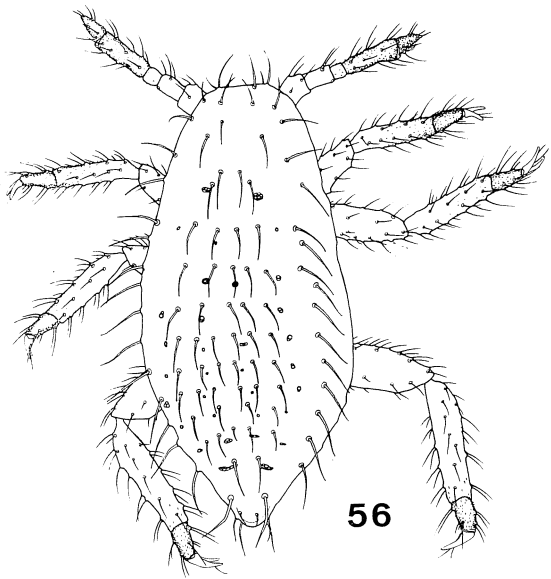
54



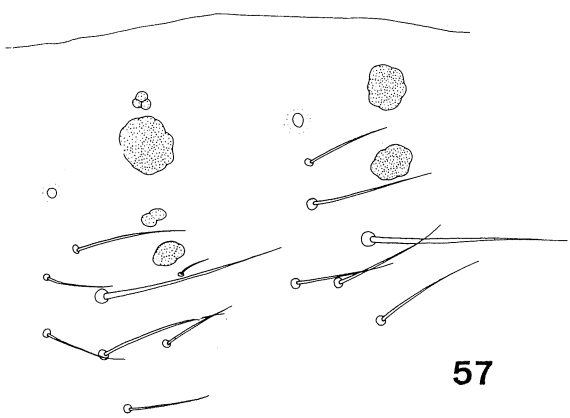
55

Larvae I of: 54. *T. caerulescens* Pass. from grass roots, France; 55. *T. ulmi* L., 3rd gen., Netherlands, x 88.

Plate VIII.

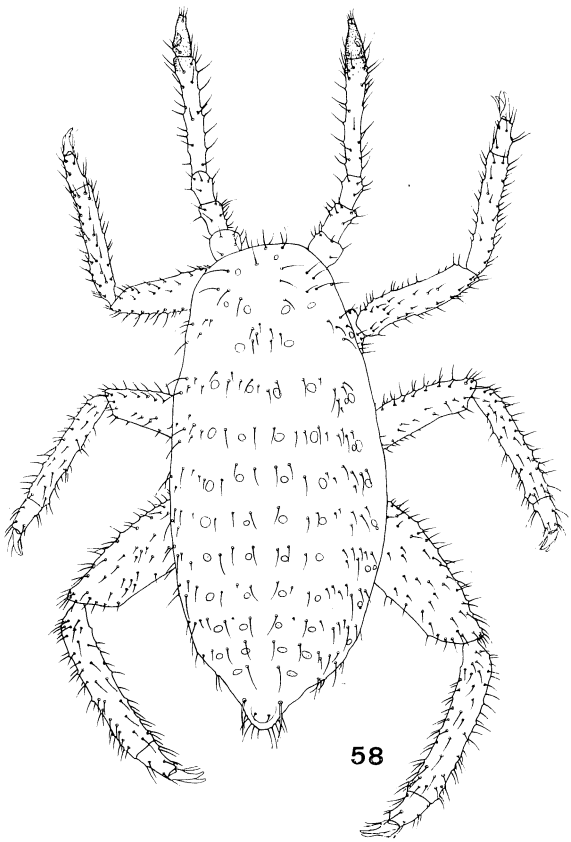


56. Larva I of *T. nigriabdominalis bispina* subspec. nov., from grass roots, Kenya, x 68.



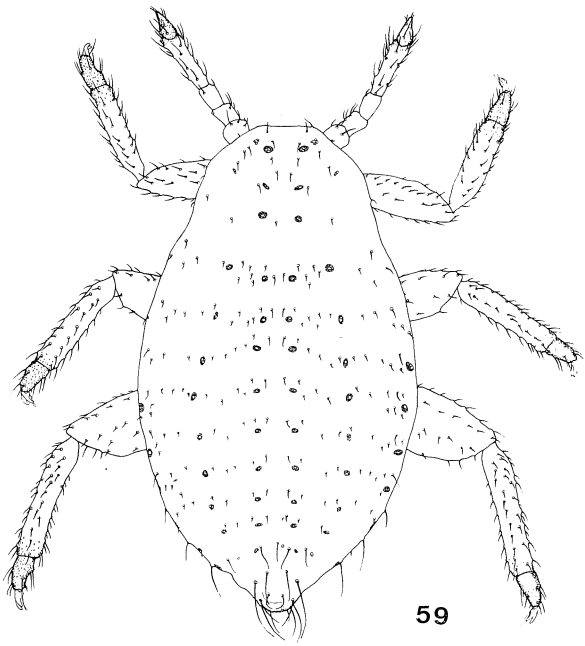
57. Marginal hairs with ventro-lateral wax glands of larva I of *T. polychaeta* spec. nov., 3rd gen., Pakistan, x 330.

Plate IX.



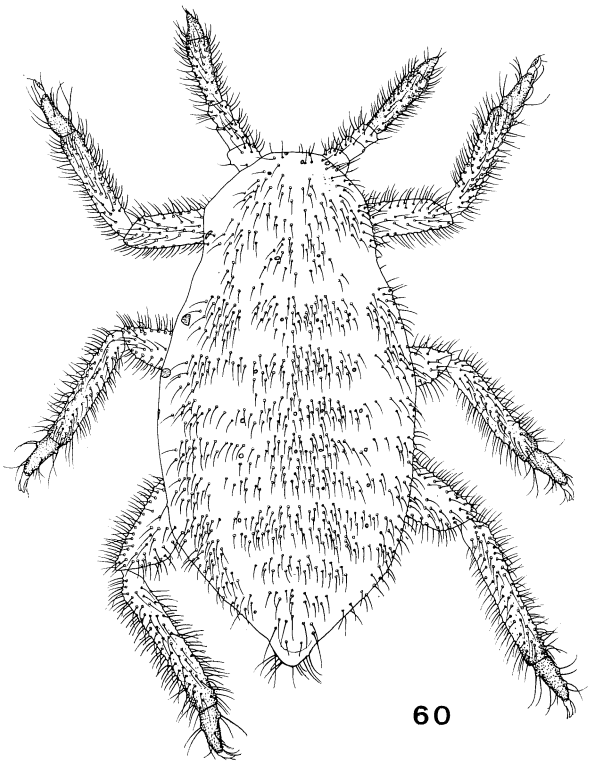
58. *T. polychaeta* spec. nov., larva I, 3rd gen., Pakistan, x 51.

Plate X.



59. *T. africana* v.d. Goot, larva I, from grass roots, Iran, x 51.

Plate XI



60. *T. radicicola* Strand, larva I, from grass roots, Malaya, x 56.