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CONCERNING A NEW RHIZOGlyphID MITE WITH COMMENTS ON THE OCCURRENCE OF HETEROMORPHIC MALES

by H. H. J. NESBITT *

TAXONOMY ABSTRACT: Rhizoglyphus fumouzi nov. spec., taken from a Narcissus (Daffodil) bulb from the Netherlands is described and figured. Comments are also offered about the incidence and percentages of heteromorphic and ambiomorphic males in the initial population and subsequent rearings.

TAXONOMIE RÉsumé: Rizoglyphus fumouzi nov. spec., obtenu d’un oignon de Narcissus (Jonquille) originaire des Pays-Bas, est décrit et dessiné. S’ajoutent des observations sur la fréquence des mâles hétéromorphes et ambiomorphes dans les populations initiales et les générations ultérieures.

In September of 1990 a population of approximately 225 rhizoglyphid mites came to my attention on a Daffodil bulb (King Alfred variety) that had been imported from the Haarlem area of the Netherlands to Ottawa, Canada. Upon first examination two characters not common in such populations were apparent, viz., the percentage of heteromorphic males was higher than has been noted in such “wild” populations, (I have never found the percentage of heteromorphic males in either the genus Rhizoglyphus or Caloglyphus to be higher than 4 to 5% of the total population; WOODRING (1969) cites 1%) and the presence of what I propose to call “Ambiomorphic” males. HUGHES (1976—p. 120) has commented on this type of male but did not give it a name. These differences lead me to believe that these mites constitute a new species which is rather similar to Rhizoglyphus echinopus F. & R. or R. solani Oudemans and which I propose to call Rhizoglyphus fumouzi.

Rhizoglyphus fumouzi n.sp.

Homomorphic male (figs. 1,2,5,6 and 7)

Exclusive of the gnathosoma the holotype measures 610 long and 424 wide (all measurements are given in microns); the paratypes vary from 596 to 650 long and 410 to 430 wide; in contrast to the female the body is widest in the humeral area and tapers posteriorly. The dorsal setae are plain and, when longer, flexible; in the living state they are carried arched over the body. Their lengths, expressed as a fraction of the distance $r$ (between the centres of attachment of the setae) will be followed in the description) are as follows: dori $0.5$, ve $0.01$ (arising from a notch in the lateral margin of the dorsal scutcheon, sci $0.02$, see $0.16$, dl $0.03$, d2 $0.03$, d3 $0.06$, d4 1.2, he 1.1, la $0.05$, lp $0.5$, sae $0.6$, sai $1.1$; the supra coxa seta is $0.2r$ and

* Department of Biology, Carleton University, Ottawa, Ontario, Canada K1S 5B6
Figs. 1-6: *Rhizoglyphus fumouzi* n. sp.

1. — Male, dorsal view (bar alpha = .2 mm). 2. — *Idem*, ventral view. 3. — Female, dorsal view, left side; ventral view, right side; inserts: Grandjean's organ delta above, insemination apparatus below. 4. — Female, leg I, tarsus, tibia and genu. 5. — Heteromorphic male, leg III. 6. — Homomorphic male, leg III.

Omega 1 = first solenidion of tarsus; omega 2 = second solenidion of tarsus; omega 3 = third and terminal solenidion of tarsus; eta = famulus episola; phi = solenidion of tibia; ba = dorsal medial seta (characteristic of all rhizoglyphids); wa = ventral medial seta; sigma 1 and 2 = solenidions 1 and 2 of genu; e = postaxial terminal tarsal seta; s = preaxial terminal tarsal seta.
slightly pectinate. Grandjean's organ $\Delta$ (vide fig. 1 insert) is bifurcate — one tine is always shorter. Ventrally, most of the bristles of an acarid mite are present; those on the coxae of all four legs, the two paragenitals and $pa\ 1$ are approximately $0.25\ \alpha$; setae $pa\ 2.8$ and $pa\ 3.1.2$ (as in most known rhizoglyphids the insertions of these four setae form a distinct arc close to the hind margin of the body). The posterior rim of the anus is removed from the hind margin of the body by a distance almost equal to its own length and it is flanked by the copulatory suckers, each of which bears anteriorly a minute bristle and centrally a barely perceptible rosette — the insertion of the adductor muscle. (In some Manson's species e.g. $R.\ singularis$ (1972) these "rosettes" are much more clearly delineated). The aedeagus (vide fig. 7), flanked by the genital bollards is a thin slightly bent tube, housed in, and supported by, the heavily sclerotized and pigmented "phallomeres". Apodemes III and IV of both males and females are unique in having a minute thorn-like seta on their proximal ends close to the point of "articulation" with the coxa. Legs I and II are similar to those of the female (vide fig. 4) and differ from most of those of the described species of the genus $Rhizoglyphus$ in that the tarsi are longer and thinner; the pretarsus (caruncle) is barely noticeable. The tarsi of legs I and II bear respectively 3 and 2 falcate terminal setae whose shafts are almost equal in length to the tarsus. Setae $ba, ao2$ and $wa$ are heavier by one-quarter that the same setae in the female (vide fig. 4); $\varphi$ of the tibia of legs I and II extends beyond the claw. (Leg III will be described in some detail below). As in all rhizoglyphids $\varphi$ of the tibia of the male is a distinct blunt spine rather than the elongate seta of the female.

**Female** (figs 3,4 and 10).

The allotype measures 720 long and 416 at the widest part of the opisthosoma; the paratypes vary from 640 to 902 long by 416 to 520 wide (only gravid females were used in these measurements and the number of eggs varied from two to seven). In shape the opisthosoma is more globular than that of the male and, in many specimens, the posterior margin is indented about the opening to the bursa copulatrix (vide insert fig. 3). The dorsal setal pattern and the length of the setae are similar to those of the male; ventrally the setae, anterad of legs IV, are as in the male. The anus is terminal and flanked by three pairs of minute setae, the middle pair of which is probably $pa\ 1$; $pa\ 2$ is missing. The opening of the bursa copulatrix is terminal and leads by a sclerotized duct into the receptaculum seminis. The setation of the legs is as in the males except that the major setae of tarsus I and II are slighter and $\varphi$ of tibia IV is whip-like rather than resembling the spine of the male, and the tarsal copulatory suckers of the male III are missing. The chelicerae of the mite are heavy (vide fig. 10) and equipped with three distinct teeth on the fixed and moveable digit.

**Heteromorphic male** (figs. 5 and 11)

The paratypes vary from 620 to 880 long and 450 to 500 wide and bear the same dorsal and ventral setae as the homomorphic male and the female, but
Figs. 8-13: *Rhizoglyphus fumouzi* n. sp.

Leg I: \( \omega = \) solenidion of tarsus; \( \phi = \) solenidion of tibia; \( \text{ro} = \) racket organ; \( gT = \) dorsal seta of tibia; \( hT = \) ventral seta of tibia. Leg III: \( e = \) postaxial terminal tarsal seta; \( s = \) preaxial terminal tarsal seta. Male apparatus (intromittent organ): \( a = \) aedeagus; \( p = \) "phallomers"; \( c = \) genital bollards.

Differ in that setae \( sae, he, d3, d4, sai, pa2 \) and \( pa3 \) are one-fifth longer and heavier; the dorsal escutcheon and the areas about apodemes I-IV are more distinctly shagreened and heavily pigmented (dark mahogany); and the third pair of legs (vide figs. 5 and 11) are noticeably grosser and terminate in a tarsus that is modified as a curved process that bears basally several setae (that might be homologized with the tarsal setae of the homomorphic male) (vide figs. 5 and 8) and four falcate terminal setae, that, compared with those of the homomorphic male, have much longer shafts. (It is interesting to note that the shape and disposition of the setae on the numerous specimens examined varies considerably). This sex, in the living state can be easily recognized by its awkward gait.

*Ambiomorphic male* (fig. 7).

The eight paratypes vary from 600 to 780 long and 440 to 460 wide. They are similar in all details.
to the normal homomorphic male on one side of the body and to the heteromorphic male on the other; i.e., one side has the modified third leg and the somewhat longer and heavier setae, while the other has the typical rhizoglyphid third leg and the shorter setae. Apart from these differences the two sides of the body are mirror images of each other. Hughes (1976) noted this form but did not give it a name. These males copulate with the tritonymph females (it might be noted that when the original population of this species was examined an ambimorphic male, and female in copulo, were taken to establish population “C” (vide infra) and the subsequent population demonstrates the usual percentage of the two forms of the male and the female. Furthermore when copulating males and females are isolated in breeding cells the usual number of eggs for the homomorphic x female cross is obtained and these exhibit the typical percentage of fertility).

**Fig. 14:** Rhizoglyphus famouzi n. sp., photomicrograph of the sucker plate of hypopus — insert, enlarged view of epimeral seta.

**Fig. 15:** Rhizoglyphus famouzi n. sp., venter of propodosoma of hypopus.

**Hypopus (figs. 12-15).**

The paratype hypopodes measure 368 long by 264 wide to 356 long by 248 wide. The propodosoma bears three pairs of setae that would appear to be homologous with *vl*, *ve* and *sce* of the adult; the hysterosomal setae are minute and adumbrate those of the adult; the suction-plate on the venter differs only slightly from that of the known species of this genus; the epimeral setae of coxae 1 and 3 are shown in fig. 14 (insert) and 15. The most conspicuous feature of the hypopus is the unusually large and thorn-like setae on the tibia I and II (vide fig. 12). The racket organs (ro) of tarsus I have shorter and more robust stalks than in most described species. It might be noted in passing that no hypopodes were found in the original population and that they only appeared after several months in old cultures where faecal matter had accumulated.

The other immature stages do not need description; suffice it to say, the configuration of the
dorsal setae of the nymphs is as in the females; the setae are however a fifth shorter in length. About one hundred tritonymphs were reared in isolation (individual cells) and, under the magnification that could be used without killing them, no differences were noted in the setae or the third leg, between those destined to be homomorphic or heteromorphic males. The "bruststeile" (or urstigmata of some authors) is shown in fig. 8.

Types:

Holotype found on a Daffodil (var King Alfred) (Narcissus sp.-var.) bulb at Ottawa, Canada, September 23, 1990; bulbs imported from Haarlem area of the Netherlands, Coll: H.H.J. NESBITT. Deposited in Canadian National Collections, Ottawa, Canada No. 21627, Allotype: same data. Paratypes 33 specimens same data: this species has been given the specific name fumouzi to honour the memory of Armand Fumouzi, who with Charles Robin in 1867-68 published the best drawings and description of a Rhizoglyphus (viz., echinopus) to date.

Discussion

The species described falls in that group of species in the genus where the setae sei are extremely minute or non existant and it appears to be most closely related to Oudemans' R. solani (1924). Our knowledge of this species has to be based on the slides and drawings (Nos. 1379-1385) deposited in the Rijksmuseum van Natuurlijke Historie in Leiden as Oudemans' original description is somewhat skimpy *. Dr. Buijendijk (1945) listed five areas in the Netherlands, two from France, and one from Germany where this mite had been found. My comments are based on two males and one female specimen (not cited on the slide as any form of "type") from Wageningen — no specimen from the "type" locality, Arnhem, was available when I examined the slides of this species. R. fumouzi differs from R. solani in the following details: legs I and II and especially the tarsi are almost equal in length to the two preceding segments, are more delicate and bear terminally three falcate setae, only two in solani; the anus of the female is terminal and lacks the four minute setae Oudemans shows posterad of the anus in solani (vide Oudemans' plate 1383); Grandjean's organ Δ is always bifurcate (vide insert fig. 1 and 3) in fumouzi, single in solani (vide Oudemans' plates 1382 and 1385); the lateral setae of tibia I and II of the hypopus are noticeably heavier than in solani and lastly the genital setae α1 and α2 are heavier and more proximally curved than in solani (or any other Rhizoglyphus specimen that I have studied).

The species described above is similar to Van Eynhoven's R. engeli 1968 from Freesias and might be considered a subspecies of the latter but, I believe the large percentage of heteromorphic males in the original population of R. fumouzi indicates that it is different. On specific details setae D3 is longer, the supra coxal seta shorter by a half, the propodosomatic shield is much less heavily shagreened, and there are three falcate setae on leg I and two on leg II rather than the single seta as illustrated by Van Eynhoven, 1968. Furthermore the Dutch author makes no reference to finding heteromorphic males in his sample nor does he figure the hypopus.

When the species described above is compared with Lin Zhonghua and Ding Tingzong's R. narcissi from the Chinese Narcissus tazetta var Chinensis the shape of the aedeagus, blunt in the Chinese species are long and spoutlike in fumouzi, the disposition of the posterior opisthosomal setae of narcissi compared with those of fumouzi and the degree of shagreenicity of the propodosomatic shield indicate that these are separate species. (The drawing, No. 7, given by the Chinese authors gives us no information about the nature of the terminal falcate setae of leg I).

* In translation Oudemans' original description p. 258 reads as follows "Rhizoglyphus solani nov. spec. on rotting potato tubers; it may be identified by 6 short bristles on the first third of the hysterosoma while on the rear half one pair of somewhat larger [setae] are implanted Arnhem".
It might be moted in passing that, at the temperature given below, this species completes its development in 11 ± .5 days and that the mature females live an average of 8.2 days and produce approximately 426 eggs of which 91% hatch.

**Breeding Experiments**

When the “wild” population (approximately 275 mites — all stages) that supplied the type specimens of *Rhizoglyphus fumouzi* n.sp., was first observed the unusually high percentage of heteromorphic males and the presence of ambiomorphs lead me to believe that this species deserved further study. In 1990 a like population, but of *Rhizoglyphus echinopus* (F. & R.) taken also from daffodil bulbs from the Netherlands and raised under similar experimental conditions failed to produce any heteromorphic males.

**Method**

From the “wild” population three pairs of copulating mites were selected to establish three separate populations: A a female (or tritonymph) and a homomorphic male, B a female and a heteromorphic male, and C a female and an ambiomorphic male (in view of the rarity of this form it was fortuitous that a copulating pair were found when the original specimens were first examined). The “wild” population D was continued as a fourth population and as a control. All four were raised under identical conditions, viz., 22°C and 80-85% r.h. and fed weekly on the bulb-scales (or bracts) of dismembered and sterilized daffodil bulbs that came from the same collection as the bulb that had supplied the original specimens. Until needed all bulbs were stored under refrigeration at 3°C. After three weeks when the populations had become established sampling was begun. The procedure followed was that the mites (adults, immature stages and eggs) on a fresh scale and returned to the population from whence they had come. Thus 100 mites from each of the four populations A, B, C, and D were examined weekly, a total of 400 in all. In Table I these numbers are combined in four week totals and expressed as a percentage of the 1600 mites examined for that period for the four different crosses (A, B, C and D). Because these mites are slow moving and because each week’s sampling was returned to the population on a fresh bulb scale and, as the adults do not live for more than 8-10 days, there was little possibility that the same adults are counted in subsequent examinations.

At the end of twelve weeks the supply of daffodil bulbs was exhausted and as none of the “September collection” was available all populations were transferred to potato and sweet potato tubers. No overall diminution in numbers was noted except that the percentage of the heteromorphic males decreased quite dramatically within seven days to 60% of the total population and finally to 0% at the end of 20 weeks by which time 8000 mites had been examined.

At the conclusion of the experiment in May 1990 the four populations were set aside and only fed fortnightly for the summer months. In September of 1991 when fresh daffodil bulbs became available these were offered to three populations taken from A, B (above) and from a third new population E descended from the hypopodes only of the old population D. The descendents of the original “wild” population D were left on a food of potato and sweet potato (to act as a control). Within three weeks appreciable numbers of heteromorphic males (estimated at 7-8%) had appeared in populations A, B and E, none could be found in D (the control).

**Results**

From the data summarized in Table I three observations are worth considering: first, from the figures, it would appear that the nature of the original cross, viz, female with homomorphic male, female with heteromorphic male, female with ambiomorphic male or female in unrestricted crossing, had no effect in predetermining the percentage
of homo-, hetero — or ambiomorphic males in the subsequent phases of the population. Secondly, as change of food after twelve weeks from daffodil bulbs to potato and sweet potato was the only variable in the experiment with the subsequent elimination of heteromorphic males, the inference appears to be valid that there is some factor in daffodil bulbs that is responsible for releasing the gene or (suite of genes) for the production of heteromorphic males in Rhizoglyphus fumouzi. Thirdly, the changing of food had no effect on the number of eggs laid or on the final number of mites reaching adulthood.

The question of the distribution of heteromorphic males in this genus needs further study. Presumably this type of male is widely distributed in the Rhizoglyphinae as it has been recorded from several species in the genera Acoyledon, Caloglyphus, Rhizoglyphus and Schwiebea. When not reported the absence might be attributed to the fact that only small numbers were available when a species was described or that the “releasor” which would activate the gene for heteromorphism was not in the food on which that particular population was found. This explanation cannot be the complete answer because in the previous year (1989) a population of Rhizoglyphus echinopus (Fumouze and Robin), from daffodil bulbs, taken in Ottawa and reared under identical conditions with those described above, and for the same length of time, failed to produce any heteromorphic males. Thus other hereditary or environmental factors must be active. (A reference might be made to Hughes 1976 review of Woodring’s 1969 paper.)

Ambiomorphic males were rare in R. fumouzi. Hughes (1976, p. 120) states that “occasionally this modification occurs” in Rhizoglyphus robini Clap. but offers no explanation. From the studies

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**Table 1: Results of breeding of Rhizoglyphus fumouzi n. sp.**

<table>
<thead>
<tr>
<th>Population</th>
<th>%</th>
<th>% (homo)</th>
<th>% (hetero)</th>
<th>% (ambi)</th>
<th>% Total Exam</th>
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<tbody>
<tr>
<td>A</td>
<td>204</td>
<td>147</td>
<td>60</td>
<td>2</td>
<td></td>
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<tr>
<td>B</td>
<td>198</td>
<td>136</td>
<td>62</td>
<td>1</td>
<td></td>
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<tr>
<td>C</td>
<td>205</td>
<td>139</td>
<td>58</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>D</td>
<td>197</td>
<td>135</td>
<td>56</td>
<td>0</td>
<td></td>
</tr>
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<td>557</td>
<td>34.8</td>
<td>14.7</td>
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<tr>
<td>A</td>
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<td>0</td>
<td></td>
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<td>B</td>
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<td>145</td>
<td>57</td>
<td>0</td>
<td></td>
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<tr>
<td>C</td>
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<td>0</td>
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</tr>
<tr>
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<td>137</td>
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<td>556</td>
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<td>B</td>
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<tr>
<td>C</td>
<td>211</td>
<td>137</td>
<td>50</td>
<td>1</td>
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</tr>
<tr>
<td>D</td>
<td>209</td>
<td>143</td>
<td>46</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>825</td>
<td>572</td>
<td>35.7</td>
<td>201</td>
</tr>
</tbody>
</table>

All cultures placed on new diet at end of 12 weeks.

| A          | 201 | 173      | 26         | 1        |             |
| B          | 205 | 170      | 27         | 0        |             |
| C          | 198 | 171      | 21         | 0        |             |
| D          | 207 | 173      | 22         | 0        |             |
|            |     | 811      | 690        | 43.1     | 96          | 6.01 3 .018 1600 |
| A          | 213 | 189      | 0          | 0        |             |
| B          | 209 | 185      | 0          | 0        |             |
| C          | 212 | 182      | 0          | 0        |             |
| D          | 217 | 192      | 0          | 0        |             |
|            |     | 822      | 747        | 47.0     | 0           | 0 .0 1600 |

Total 8000

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reported above I could suggest that ambiomorphy might be associated with the first division of the zygote into the two daughter cells. Since the two sides of the body of this form are mirror images of each other, except for the hind legs and the difference in the length and robustness of some of the dorsal setae, this observation would be consistent with a non-disjunction of the chromosome pair that carry the genes responsible for the heteromorphic type of male.

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