

Cytological and morphological differences within Palaeartic *Glyphina* (Homoptera: Aphididae), and their taxonomic significance

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ABSTRACT. Karyotype variation within the genus *Glyphina* in Europe is described and correlated with morphological differences. *G.pseudoschrankiana* sp.nov., on *Betula pubescens* in Europe and Japan, is separated from *G.schrankiana* Börner, on *Alnus* spp. in northern and central Europe, on the basis of differences in karyotype and morphology. *G.jacutensis* Mordvilko is synonymized with *G.schrankiana*. A key is provided to Palaeartic members of the genus.

Introduction

Glyphina is a small genus of birch- and alder-feeding aphids, with four species currently recognized: two in Europe and Asia, and two in North America. The two European species, *G.betulae* (L.) and *G.schrankiana* Börner, were thought to be difficult to tell apart until Szelegiewicz (1982) pointed out that the problem of distinguishing between them had been compounded by the supposition that each species was confined to a particular plant genus. According to Szelegiewicz, the apterous viviparae of *G.betulae* live only on *Betula* spp., and have a warty (denticulate) ornamentation of the dorsal cuticle, whereas those of *G.schrankiana* live on *Alnus* spp. but can also occur on *Betula pubescens*, and have a dorsal ornamentation composed of short wrinkles or incomplete reticulations. Szelegiewicz also noted that *G.betulae* has fewer and shorter hairs on the antennae and abdominal tergites than *G.schrankiana*, and its alatae have fewer secondary rhinaria on the third antennal segment.

Blackman (1980) noted a difference in chromosome number in European *Glyphina*. A

population from *Betula* in Britain had $2n(\text{male})=55$, whereas Kuznetsova & Shaposhnikov (1973) had reported $2n(\text{female})=10$ for samples from both *Betula* and *Alnus* in the U.S.S.R. The aphids karyotyped as $2n=55$ ran to *G.betulae* in Szelegiewicz's key, and it therefore seemed likely that both the $2n=10$ samples examined by Kuznetsova & Shaposhnikov were *G.schrankiana*.

With the acquisition and karyotyping of more samples, however, it has become apparent that the situation is more complex, both cytologically and taxonomically.

Karyotypes

Four different karyotypes have now been found in European *Glyphina* (Fig. 1).

$2n(\text{female})=8$. Two populations, one from *Alnus incana* in Rumania (coll. A. Czylok, June 1984), and the other from *A.glutinosa* in Lithuania (coll. R. Rakauskas, May 1986), were found to have $2n=8$ in female somatic cells (Fig. 1a). In prophase and prometaphase cells there often appeared to be two additional, dot-like chromosomes (Fig. 1b). This is because the X chromosomes have subterminal nucleolar organizing regions (NORs), and a terminal fragment

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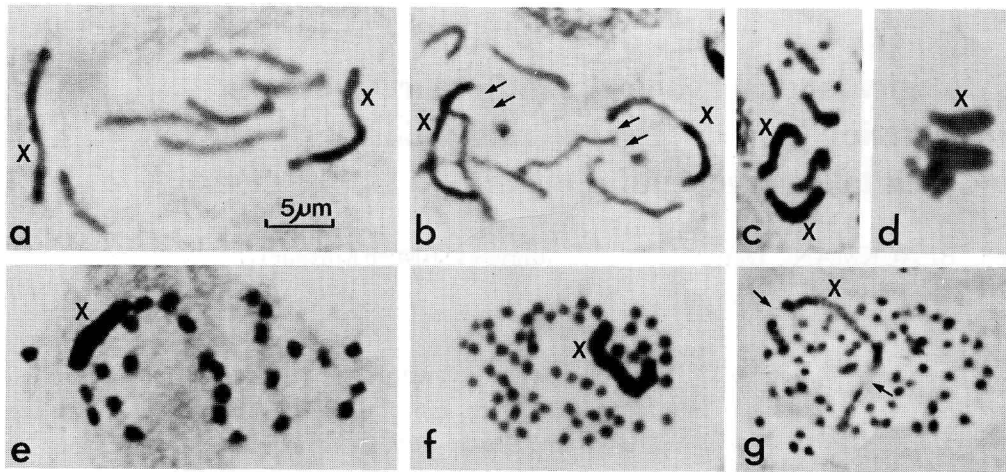


FIG. 1. Chromosomes of European *Glyphina* species. a, somatic cell prometaphase, $2n(\text{female})=8$; b, somatic cell prophase, $2n(\text{female})=8$, with terminal part of each X chromosome separated by an NOR constriction (arrowed); c, somatic cell prometaphase, $2n(\text{female})=10$; d, metaphase I of spermatogenesis in $2n=10$ form, showing four autosomal bivalents and the univalent X chromosome; e, somatic cell metaphase, $2n(\text{male})=27$; f, somatic cell metaphase, $2n(\text{male})=55$; g, somatic cell prophase, $2n(\text{male})=55$, showing X chromosome with two constricted NOR regions (arrowed).

of the X becomes separated from the remainder by the nucleolus in prophase cells.

$2n(\text{female})=10$. Populations with this karyotype have so far been found in south-east England at Kew Gardens and Twickenham, London, in both cases on unidentified *Betula* spp. (not *pendula*), and at Jälla, Sweden, on *B. pubescens*. Two pairs of short, dot-like chromosomes are present, which seem too short to be equivalent in DNA content to one of the longer chromosomes of the $2n=8$ form (Fig. 1c). Therefore the difference cannot be attributable to a single dissociation or fusion event, as is often the case when two closely related aphid species have different chromosome numbers (Blackman, 1980), but must be due to some more complex rearrangement. The X chromosomes have a similarly-placed NOR to those of the $2n=8$ form, so that cells in prophase usually appear to have twelve separate elements, with three pairs of dot-like chromosomes.

Male embryos with an unpaired X chromosome ($2n=9$) were found in viviparae collected in June, and stages of spermatogenesis were obtained from preparations of the testes of immature males collected in July. Metaphase I spermatocytes had four bivalents and one univalent, the unpaired X chromosome (Fig. 1d).

$2n(\text{female})=56$. Four samples with this

karyotype have been obtained, all from *B. pendula*. Two were from England (Burnham Beeches, Bucks., coll. V. F. Eastop, July 1975; and Bewdly, Worcs., coll. M. W. Robinson, June 1985), and two from Lithuania (coll. R. Rakauskas, at Vilnius, May 1986; and at Puvociai, August 1986). Males have $2n=55$, with a single X chromosome. The 54 autosomes, presumably 27 pairs, were all dot-like and very small (Fig. 1f). Prophase cells revealed an unusual feature of the X chromosome: as in $2n=8$ and $2n=10$ forms, the nucleolar organizer region was not terminal, but in this case there were two NORs, placed equidistant from each end of the X chromosome (Fig. 1g).

$2n(\text{female})=28$. A population from *Betula pendula* at Katowice, Poland (coll. A. Czylok, July 1984), was found to have male embryos with $2n=27$, comprising 26 dot-like autosomes (presumably 13 pairs), and one long unpaired chromosome (Fig. 1e). Female somatic cells were not seen but presumably have $2n=8$ with a pair of Xs. The long X chromosome has two NORs and is similar to that of the $2n=56$ form.

Morphology

Morphological characters of apterous viviparae from karyotyped samples are compared in Table

TABLE 1. Morphological data for individual apterous viviparae of different *Glyphina* karyotypes (p.t. = terminal process).

2n (female)	Collection locality	Date	Dorsal ornamentation	Body length (mm)	Lengths of antennal segs (mean of two sides in mm)					Last rostral seg. (mm)	Hind tarsus II (mm)	Hair lengths (in μ m) on:				Hair numbers on:			
					III	IV	V	V	(p.t.)			Ant. seg III	Abd. tergites 3	5	8	Ant. seg. III	Abd. terg. 3	4	5
8	Georgeni, Rumania	23.vi.84	Wrinkled	1.75	0.275	0.096	0.103	0.040	0.174	0.142	47	42	47	75	12/12	12	10	7	3
8	Vilnius, Lithuania	27.v.86	Wrinkled	1.95	0.290	0.109	0.120	0.041	0.175	0.149	52	43	45	75	14/15	11	11	6	3
8	Kew, U.K.	11.vii.84	Wrinkled	1.84	0.306	0.127	0.127	0.041	0.175	0.142	48	45	52	67	19/18	14	8	7	2
10	Jälla, Sweden	28.v.87	Wrinkled	1.71	0.264	0.119	0.134	0.041	0.164	0.142	52	45	52	60	15/17	11	8	6	2
10	Katowicz, Poland	28.vii.84	Wrinkled	1.54	0.270	0.116	0.150	0.049	0.178	0.133	44	66	61	85	13/12	11	9	7	3
10	Burnham Beeches, U.K.	24.vii.75	Wrinkled	1.71	0.292	0.120	0.156	0.049	0.179	0.137	54	62	69	77	13/12	10	9	6	2
10	Katowicz, Poland	28.vii.84	Warty	1.68	0.240	0.097	0.149	0.037	0.157	0.134	44	52	54	82	9/8	11	9	6	3
28	Burnham Beeches, U.K.	24.vii.75	Warty	1.69	0.254	0.093	0.149	0.037	0.187	0.128	45	53	56	67	9/10	12	8	8	4
28	Vilnius, Lithuania	27.v.86	Warty	1.44	0.220	0.081	0.106	0.032	0.163	0.133	38	39	40	57	10/10	7	7	4	2
28	Burnham Beeches, U.K.	24.vii.75	Warty	1.62	0.190	0.086	0.111	0.030	0.162	0.134	38	34	38	54	10/9	10	9	5	3
28	Vilnius, Lithuania	27.v.86	Warty	1.41	0.172	0.086	0.108	0.029	0.166	0.136	42	35	40	47	10/10	9	8	5	2
28	Burnham Beeches, U.K.	24.vii.75	Warty	1.24	0.135	0.080	0.086	0.030	0.148	0.118	31	38	38	53	10/8	8	7	4	4
56	Burnham Beeches, U.K.	24.vii.75	Warty	1.95	0.245	0.090	0.119	0.030	0.170	0.147	51	45	45	57	13/13	11	8	5	3
56	Vilnius, Lithuania	27.v.86	Warty	1.72	0.226	0.101	0.108	0.035	0.184	0.146	49	40	43	57	13/11	9	8	5	3
56	Vilnius, Lithuania	27.v.86	Warty	1.65	0.199	0.086	0.119	0.022	0.170	0.134	46	39	37	51	7/9	8	7	5	3
56	Vilnius, Lithuania	27.v.86	Warty	1.51	0.153	0.078	0.109	0.024	0.157	0.122	40	37	37	54	7/7	7	8	6	4

1. Specimens with 2n=8 and 2n=10 have a predominantly wrinkled dorsum, and correspond with Szelegiewicz's conception of *G.schrankiana*, whereas specimens with 2n=28 and 2n=56 have a predominantly warty or denticulate ornamentation of the dorsum, and agree with his conception of *G.betulae* (Fig. 2).

Comparing the 8-chromosome form with the 10-chromosome form, the 2n=8 aphids have the base of the fifth antennal segment shorter than the second segment of the hind tarsus, whereas the 2n=10 aphids have the base of the fifth antennal segment longer than the second segment of the hind tarsus. This difference showed complete correlation with both karyotype and host plant for all specimens examined, and this as well as several other consistent differences (see below) confirmed that the 2n=8 form on *Alnus* and the 2n=10 form on *Betula* are distinct species.

When specimens of the 2n=28 sample were compared with 2n=56 aphids, however, it was not possible to find any consistent morphological differences. The taxonomic separation of the single 2n=28 sample from those with 2n=56 on the basis of chromosome number alone is not justifiable, so without more samples and further information it is wisest to consider these two karyotypes as chromosomal races of the one species, *G.betulae*. Although the chromosome number of the 2n=56 form is double that of the 2n=28 form, this does not appear to be a case of polyploidy, as there is in each case a single pair of X chromosomes. It seems most probable that the karyotype has evolved by sequential dissociations of autosomes, as appears to have happened in several other aphid genera (Blackman, 1980).

Nomenclature

Glyphina schrankiana Börner is a replacement name for *Aphisalni* Schrank (nec *A.alni* de Geer), and should therefore be applied to an alder-feeding species, i.e. the 2n=8 aphid. Another name is needed for the 2n=10 species on *B.pubescens*. Of the available names, lectotypes of *G.betulina* Buckton in the British Museum (Natural History) collection are *G.betulae*, and the original description of *impingens* Walker also agrees closely with *G.betulae* (see Doncaster, 1961). The only other available

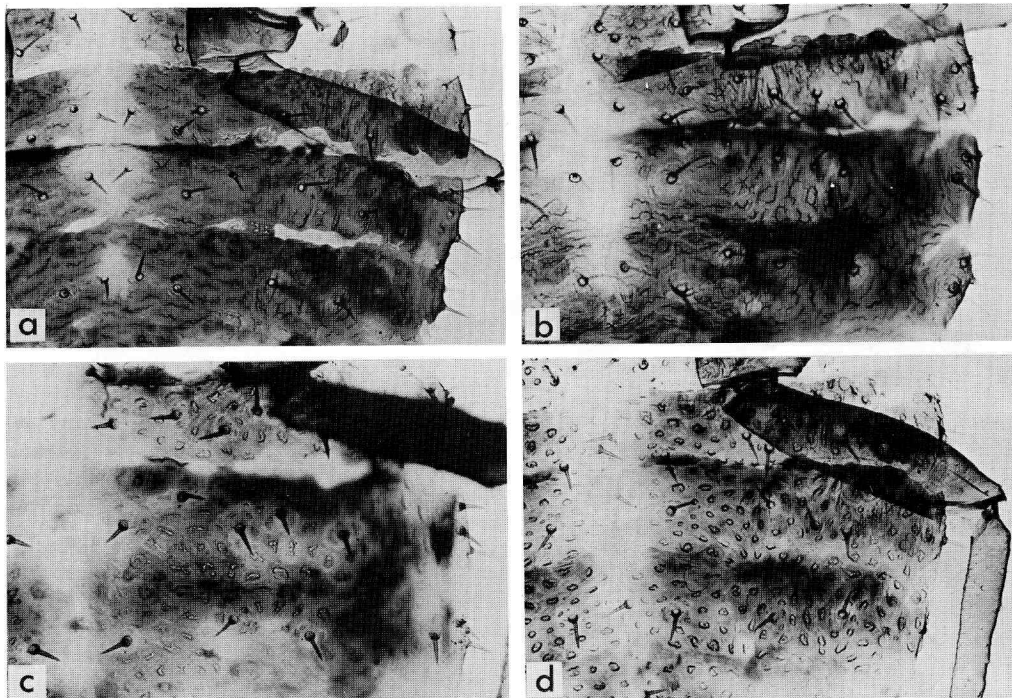


FIG. 2. Dorsal cuticle of abdominal segments 2, 3 and 4 apterous virginoparae of *Glyphina* with different karyotypes. a, $2n=8$; b, $2n=10$; c, $2n=28$; d, $2n=56$.

name is *G. jacutensis* Mordvilko (1931), the host plant of which is unknown. Mordvilko's description of this aphid refers to flat warty glands on the sides of the body, but no mention is made of their presence dorsally. Such structures are present all over the dorsum in *G. betulae*, and only on the sides of the thorax and abdomen in *G. schrankiana*. In the $2n=10$ species they are absent, except sometimes on the head and thorax (see below). *G. jacutensis* can therefore be regarded as a synonym of *G. schrankiana* syn.n., and a new name is required for the $2n=10$ species.

***Glyphina pseudoschrankiana* sp.nov.** (Figs 3a, 3c, 3e)

Appearance in life. Adult aptera black with variably developed white markings, immature stages brown. Colonies are on young growing shoots, often on young trees, attended by ants.

Apterous virginopara. Mounted specimens in many respects resemble *G. schrankiana*, but have the following distinguishing characters:

Antennae with rather stout-based hairs which are almost parallel-sided for most of their length and taper abruptly to a point, like those on head and sides of body (Fig. 3a). (Antennal hairs of *G. schrankiana* are finer than body hairs, similar to tibial hairs, tapering gradually from the base and often with finely attenuate apices; Fig. 3b.) Third antennal segment dusky, only a little paler than other segments, whereas in *G. schrankiana* it is much paler and often contrasts markedly with the dark first, second, fourth and fifth segments. Base of fifth antennal segment relatively longer than in *G. schrankiana* (see Table 2), 1.00–1.29 times longer than second segment of hind tarsus (in *G. schrankiana* 0.71–1.00 times). Ultimate rostral segment relatively longer than in *G. schrankiana*; 1.11–1.51 times longer than second segment of hind tarsus (1.04–1.26 times longer in *G. schrankiana*). Second segment of hind tarsus relatively shorter than in *G. schrankiana*.

Tergites sclerotized, pigmented, adorned with irregular wrinkles, more extensive and forming a partial reticulation in pleural areas; this sculpturing similar to that of *G. schrankiana*, but not

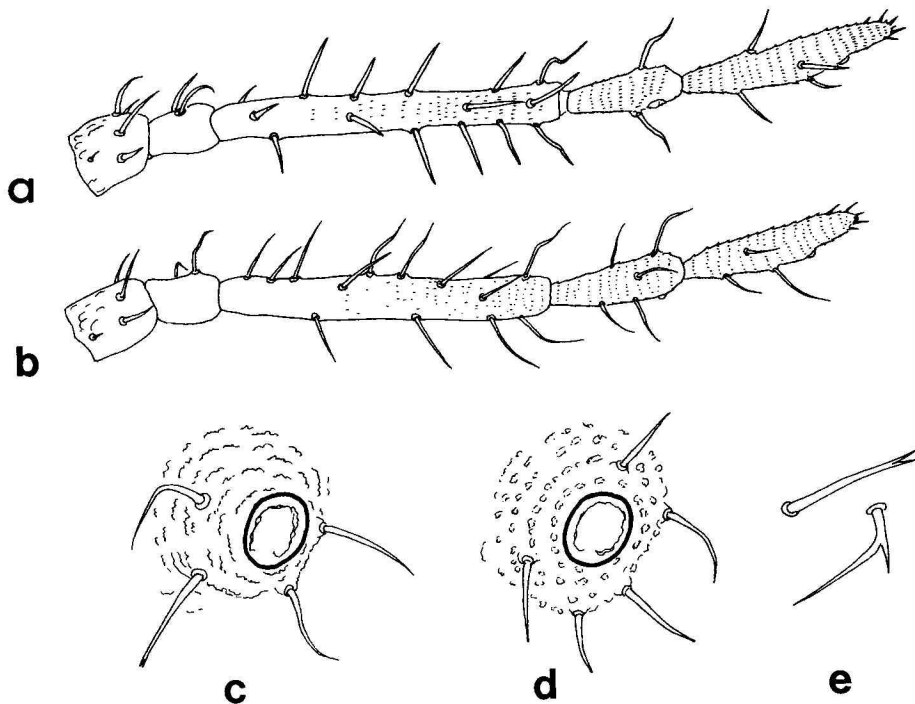


FIG. 3. a, Antenna of apterous virginopara of *G. pseudoschrankiana*; b, antenna of apterous virginopara of *G. schrankiana*; c, region of siphunculus of *G. pseudoschrankiana*; d, region of siphunculus of *G. schrankiana*; e, bifurcate dorsal abdominal hairs of *G. pseudoschrankiana*.

becoming warty or denticulate on lateral and ventrolateral areas of the meso- and metathorax and abdomen, as is the tendency in that species (Figs 2a, b). The differences in cuticular sculpturing between the two species around the siphunculus are especially distinctive (Figs 3c, d). The only areas of denticulate ornamentation in *G. pseudoschrankiana* are on the head and prothorax.

Dorsal abdominal hairs rather thick, 52–75 μm long, a little longer than those of *schrankiana*

(35–53 μm), and occasionally bifurcate, with the bifurcation sometimes quite near the base (Fig. 3e).

Alate virginopara. Very similar to *G. schrankiana*, but with more rhinaria on third antennal segment (8–9, compared with 4–7 in *G. schrankiana*), and similar differences in the relative lengths of base of fifth antennal segment, last segment of rostrum and second segment of hind tarsus to those noted for the apterous virginopara (Table 2). Dorsal abdominal sclerites are

TABLE 2. Biometric comparison of *Glyphina pseudoschrankiana* sp.n. and *G. schrankiana* (all measurements in mm).

	<i>pseudoschrankiana</i>	<i>schrankiana</i>
APTERAE: no. of specimens	25	27
Length of base of fifth antennal segment	0.135–0.160	0.090–0.149
Length of last rostral segment	0.164–0.210	0.139–0.181
Length of second segment of hind tarsus	0.132–0.151	0.139–0.160
ALATAE: no. of specimens	5	8
Length of base of fifth antennal segment	0.165–0.171	0.117–0.143
Length of last rostral segment	0.170–0.195	0.158–0.173
Length of second segment of hind tarsus	0.128–0.146	0.135–0.146

mostly separate, showing less tendency to form transverse bars across the midline than in *G.schrankiana*.

Apterous ovipara. Appearance in life unknown; macerated specimens much less pigmented than apterous virginopara, but with the same pattern of dorsal ornamentation (wrinkles and some reticulation). Smaller than virginopara (body length 0.9–1.2 mm) and with much shorter legs, the hind tibiae not swollen and lacking discernible scent glands. Other characters as in apterous virginopara. Oviparae of *G.schrankiana* were not available for comparison.

Apterous male. The single specimen available has body length 1.07 mm, base of fifth antennal segment 0.109 mm, last rostral segment 0.138 mm, and second segment of hind tarsus 0.104 mm. Antennae, like those of *G.betulae*, lack secondary rhinaria. Dorsum with dark sclerotic transverse bands ornamented with wrinkles; very distinct from male *G.betulae* which have dorsal ornamentation comprising numerous small, almost circular warts. Males of *schrankiana* were not available for comparison.

Material examined

Type material. (Type status is reserved for karyotyped material.) HOLOTYPE. Apterous viviparous female, ENGLAND: London, Twickenham, from *Betula* sp., 8.vi.85 (*Polaszek*), RLB no.3326; embryos karyotyped as $2n=9$ (male). PARATYPES. 39 apterous and 3 alate viviparae plus immatures, same collection data, karyotype (of embryos) and number as holotype; 5 apterae plus immatures, *Betula* sp., Surrey, Kew Gardens, 11.vii.84 (*Polaszek*), same locality, 21.vi.65, 5 apterae + 1 alata; ous viviparae plus immatures, *B.pubescens*, SWEDEN: Jalla, 8.v.87 (*Eastop*, VFE Coll. no. 18,279), RLB no.3817. Paratype apterae have been sent to: Zoological Institute, Academy of Sciences, Leningrad; Academy of Sciences, Prague; Institut Pasteur, Paris; Zoological Institute, Lund, Sweden; collection of O. E. Heie, Copenhagen. Holotype and remaining paratypes in British Museum (Natural History).

Other material examined. JAPAN: Mount Teine, Hokkaido, 30.vii.80, *Betula* sp., 12 apterous viviparae + immatures. ENGLAND:

Surrey, Elstead, 22.v.65, *Betula* sp., 4 apterae; same locality, 15.vi.65, *Betula* sp., 6 apterae; same locality, 21.vi.65, 5 apterae + 1 alata; Bedfordshire, Luton, 12.vi.70, *B.pubescens*, 6 apterae + immatures; Surrey, Kew Gardens, 23.vi.63, *B.pumila*, 1 alata; same locality, 3.vii.66, *Betula* sp., 34 apterae, 15 oviparae, 1 male; same locality, 2.viii.62, *Betula* sp., 3 apterae; same locality, 26.viii.62, *B.pumila* (with *Lasius niger*), 12 apterae + many immatures.

Key to palaeartic *Glyphina* species

- 1 Apterous viviparae2
- Alate viviparae.....4
- 2 Dorsal cuticle densely ornamented with numerous small warts or denticles, of irregular shape but often more-or-less circular. In life dark green to almost black with a pale spinal stripe, immatures green. On *Betula* spp., especially *B.pendula*, and occasionally on *Alnus* spp. Europe..... *betulae*
- Dorsal abdominal cuticle with numerous short wrinkles, sometimes extending into a partial reticulation; closed 'warts' only ever present on head and thorax and on lateral and ventrolateral regions of abdomen3
- 3 Base of fifth antennal segment longer (1.0–1.3 times) than second segment of hind tarsus. Hairs on third abdominal tergite longer than 50 μ m. In life black with white markings, immatures brown. On *Betula* spp., especially *B.pubescens* and related 'downy' species (not on *B.pendula*). N.W. Europe and Japan *pseudoschrankiana*
- Base of fifth antennal segment shorter (0.7–1.0 times) than second segment of hind tarsus. Hairs on third abdominal tergite shorter than 50 μ m. In life brown, immatures pale brown. On *Alnus* spp. (*A.incana*, *A.glandulosa*) in central and northern Europe (not recorded from U.K.) *schrankiana*
- 4 Third antennal segment with 8–15 hairs, but rarely with more than 12 on both antennae of the same individual *betulae*
- Third antennal segment with 13–23 hairs.....5
- 5 Third antennal segment with 8–9 rhinaria. Base of fifth antennal segment 1.1–1.3 times longer than second segment of hind tarsus, which is 0.73–0.79 of length of last segment of rostrum
pseudoschrankiana
- Third antennal segment with 4–7 rhinaria. Base of fifth antennal segment 0.8–1.0 times as long as second segment of hind tarsus, which is 0.78–0.93 of length of last segment of rostrum *schrankiana*

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