Comparisons between *Neopealius rubi* and *Bemisia tabaci* in Europe (Homoptera: Aleyrodidae)

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Abstract: *Neopealius rubi* Takahashi, originally described from Japan, appears to be a common species on blackberries (*Rubus* spp) in part of Europe. *Bemisia rosae* (Korobitsin) is considered a synonym. Comparisons between different stadia of *N. rubi*, the type-species of *Neopealius* Takahashi, and *B. tabaci* (Gennadius), the type-species of *Bemisia* Quiantance & Baker, did not provide a conclusive answer to the question whether both genera are valid. In the south of Europe *B. tabaci* has also been found on blackberries.

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Introduction

Neopealius rubi Takahashi, 1954, type-species of the genus *Neopealius* Takahashi, 1954, has been described from Japan after pupal cases from two *Rubus* spp (Rosaceae), a *Lespedeza* sp. (Leguminosae) and two *Lindera* spp (Lauraceae). Danzig (1966) detected this species on Labiatae in the Maritime Territory of the Soviet Far East. Collecting in the south of Europe by myself delivered specimens corresponding to the description of *Neopealius rubi*. Study of the type-material of *Neopalius rubi* (figs. 10-14) affirmed that the same species is concerned. The species was found, in several parts of Europe, in large colonies on *Rubus* spp and more scarce on roses and other plant species.

Descriptions of *Aleyrodes rosae* Korobitsin, 1967 and *Bemisia rosae* Dantzig, 1969, synonymized by Huldén (1986), must apply to the same species. Huldén (1986) stated that his species occurred abundantly on roses in the south of Finland. Study of some of the Visnya collection at the Hungarian Natural History Museum, Budapest affirmed that the pupal cases on *Euonymus europaeus* L. (Celastraceae), *Clematis vitalba* L. (Ranunculaceae) and *Rubus caesius* L., referred to as *Bemisia* n.sp. by Visnya (1941), also concerned *Neopealius rubi*. The species appears to have a Palaearctic distribution but is at least absent in Northwestern Europe (fig. 1). In some regions it seems more common on blackberries, in other regions more on roses.

Most authors, e.g. Visnya (1941), Danzig (1969), Huldén (1986) attributed European specimens of *Neopealius rubi* to the genus *Bemisia*. For this reason the type-species of *Bemisia* will be compared with that of *Neopalius*. The limited knowledge and availability of most of the other species, considered as belonging to one of these genera, do not allow to take these species into consideration.

Taxonomical value of adults

Whitefly species are usually described after the pupal case. In general it was agreed that the majority of species cannot be recognized as adults due to their uniformity of structures (Mound, 1973). A discriminating character in pupal cases as the vasiform orifice shows a strong similarity in the adults and also the genitalia of the adults hardly differ. This uniformity of adult structures is particularly true for the species of the temperate zone. Antennal sensoria can vary greatly in the tropics, but appear very similar in position and structure in the temperate zone throughout all genera.

This can even be demonstrated for species of the same genus. The antennae of the (sub)tropical citrus whitefly, *Dialeurodes citri* (Ash-

Fig. 1. Known distribution of *Neopealius rubi*.

mead, 1885), are densely set with sensory plates, while the antennae of the rhododendron whitefly, *Dialeurodes chittendeni* Laing (1928), of the temperate zone show the same sensoria in the pattern as given in figs. 5 and 15. This phenomenom is possibly correlated with whitefly diversity and, as a consequence, matefinding. Three species joining the same host is the maximum in the whitefly fauna of Great Britain (Mound, 1966). As many as twenty-one species could be collected from the same host, *Hexalobus monopetalus* (A. Rich.) Engl. & Diels (Annonaceae), in the tropical southwest of Chad (Bink-Moenen, 1983).

Notwithstanding these data, it seems doubtful whether species cannot be recognised in the adult stage. Up to now adult systematics never had a serious try. It appeared that besides the pupal cases, adults often have to be considered in order to gain an insight into relationships and to solve taxonomic problems (Bink-Moenen & Mound, 1990). In view of this a short description is given of both the adult of *B. tabaci* and *N. rubi*.

Material and acknowledgements

Most material studied has been collected by my husband, F. A. Bink, and by myself and deposited in my collection (CB). The syntypes of *Neopealius rubi* are preserved at the Kyushi University, Fukuoka, Japan (KU) and I am grateful to Dr Yoshihiro Hirashima for the loan of some syntypes. I am also grateful to Dr. Vásárhelyi Tamás, who kindly allowed me to study the whiteflies in the Hungarian Natural History Museum, Budapest (HNH).

Bemisia tabaci (Gennadius, 1889)

(figs. 2-9)

Aleurodes tabaci Gennadius, 1889: 1-3.
Aleurodes inconspicua Quaintance, 1900: 28-29.
Bemisia inconspicua; Quaintance & Baker, 1914: 100.
Bemisia tabaci; Takahashi, 1936: 110.
For remaining synonymy: see Mound & Halsey (1978: 118-119).

Description

Egg (fig. 9)
Smooth, usually colourless, stalk dark brown, slender, short, about one sixth of length of egg.

Pupal case (figs. 2-4)
Usually colourless. Highly variating in size, shape and length of setae, depending on host plant (Mound, 1963). Mound (1963) distinguished different forms. For shape and details of pupal case on *Rubus* spp see figs. 2-4. Length of pupal case on *Rubus* spp 650-900 μm; breadth 475-750 μm. Some specimens from *Rubus* are more alike the form on smooth leaves, others more alike the form on hairy leaves. The tubercles posterior to the lingula (fig. 4) are weakly developed in most specimens.

Table 1. *Neopealius rubi*, host plant list of European countries.

	Bulgaria	Finland	France	Hungary	Poland	U.S.S.R.
Acer campestre			x			
Euonymus europaea				x		
Clematis vitalba				x		x
Rosa canina						x
Rosa dumalis		x				
Rosa pimpinellifolia		x				
Rosa sp						x
Rosa cv		x	x			
Rubus caesius	x		x	x		x
Rubus fruticosus	x		x		x	
Rubus ulmifolius			x			
Rubus sp			x			

Adult (figs. 5-8)

Yellowish except dark brown tip of rostrum. Length without antennae: male 1140-1230 µm; female 1500-1710 µm. Length antennae male about 325 µm; female 360-390 µm. Antennae similar in both sexes; third segment longest; fourth segment shortest; segment 5-7 subequal in length. Segment 3 apically with two rhinaria and spine-like sensorium; segment 5 apically with rhinarium; segment 6 with spine-like sensorium; segment 7 with rhinarium and spike-like sensorium, both at about same distance to apex (fig. 5). Compound eyes constricted to one ommatidium (fig. 8); ommatidia in anterior part larger and brownish after complete bleaching; ommatidia in posterior part colourless after bleaching. Claws and paronychium subequal in length; paronychium hairy and with a stout seta; sensory seta on last tarsal segment present. Wings male: length forewing about 850 µm; hindwing about 750 µm; female: forewing about 1100 µm; hindwing about 950 µm. Wax plates male 95-120 µm broad, about 60 µm long, distance between rows of plates about 60 µm; wax plates female about 150 µm broad, about 75 µm long, distance between rows of plates about 70 µm. Vasiform orifice subcircular; transverse operculum with pair of stout posterior setae.

Male genitalia. Genital plate almost as long as broad, variating in shape. Claspers slightly longer than genital plate. Innerside of claspers with at least three long stout setae along membranous area and one near base; several smaller setae scattered over claspers. Penis slightly shorter than claspers (fig. 6).

Female genitalia. Inner chitinous press about 100 µm long. Valves about 75 µm long; dorsal valve with a pair of setae; lateral valves with a seta half-way and four setae on hairy basal part (fig. 7).

Material studied

France, Corse: Ile Rousse, 31.v.1976, 7 pupal cases on *Rubus* sp.; Greece, Corfu: Episcopi, 14.v.1980, 3 pupal cases, 1 male adult on *R.* cf *ulmifolius*; France: Carcassonne, 19.v.1978, 1 male adult on *Euphorbia characias* L.; idem, 9.v.1987, 2 female, 1 male adult on *Euphorbia* sp., F. A. Bink and R. M. Bink-Moenen (all in CB).

Distribution

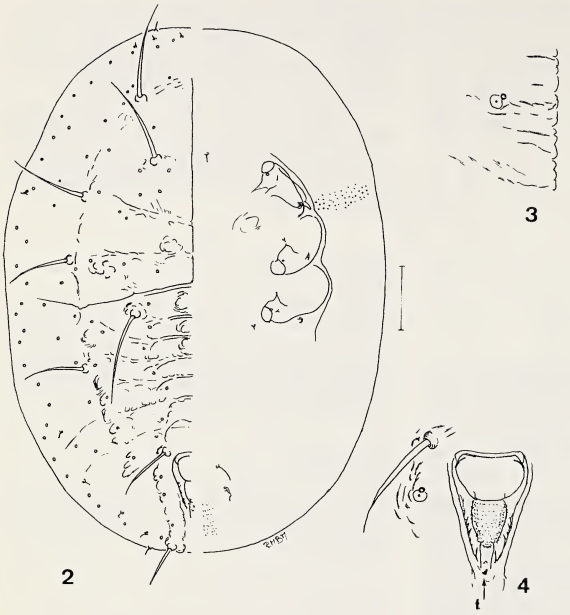
Almost cosmopolitan; for complete list of known countries see Mound & Halsey, 1978: 119-120.

Host plants

Polyphagous; for list of host plants see Mound & Halsey, 1978: 120-123.

Biology

B. tabaci is widespread in warm temperate to tropical climates. In the subtropical and tropical region it is a pest of many economic plants. For this reason it has been extensively studied. However, hardly any information exists about its biology in the south of Europe. It can be stated that the species is continuously breeding. Eggs are laid scattered on the younger leaves. In the southeast of Romania the first adults emerged in the beginning of may. The second and third instar larvae probably overwinter. These stages could be found left on their host *Euphorbia amygdaloides* L. in October, together with a few specimens of the fourth instar (Dobreanu & Manolache, 1969). For the Caucasus, Dantzig (1964) recorded dense colonies on *Cistus salvifolius* L. and dense flights of adults in the very beginning of September.



Figs. 2-4. *Bemisia tabaci* from *Rubus* sp., Corsica. 2, pupal case: leftside dorsum, rightside venter; 3, submargin; 4, vasiform orifice. t = posterior tubercles (scale pupal case 100 µm.

The following information has been derived from Avidov (1956) dealing with Israelian populations. The lower threshold for oviposition appeared to be 14 °C, for egg development about 12.5 °C and for larval development 12 °C. In Israel where the lowest average monthly temperature was 12.7 °C all stages could overwinter. The shortest recorded duration from egg to adult has been 11 days at an average monthly temperature of 26 °C, and the longest duration 75 days during winterseason at an average temperature of about 14 °C. It must be taken into account that according to his "Methods", breeding has been carried out outdoors under unshadowed conditions. Horowitz found in Israel a duration of 27 days from egg to adult under controlled conditions and an average temperature of 20.8 °C (Gerling, Horowitz & Baumgaertner, 1986).

If the same developmental times are valid for the European populations, the following number of generations can be expected. About four to five for the surroundings of Madrid (Spain) and Marseille (France), and about six for the surroundings of Athens (Greece). Two or three generations can be expected for the region of Bucaresti (Romania), where the average temperature is at least two months below zero (Walter & Lieth, 1960). The record of Dobreanu & Manolache (1969) from this region shows that *B. tabaci* is well frost-tolerant. Besides the rather high temperature required for its development, the relative humidity probably also determines its distribution. Horowitz (1986) found a high sensitiveness for relative humidities below 20% and above 80%.

Neopealius rubi Takahashi, 1954
(figs. 10-19)

Neopealius rubi Takahashi, 1954: 51-52; Danzig, 1966: 382 (207); Miyatake, 1980: 311.
Bemisia n. sp. Visnya, 1941: 14.
Aleyrodes rosae Korobitsin, 1967: 510-511.
Bemisia rosae Danzig, 1969: 870 (553).
Bemisia rosae; Huldén, 1986: 12-13. Syn. nov.

Description

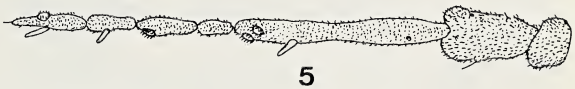
Egg (fig. 19)
Smooth, mostly brown, stalk dark brown, stout, long, about one third length of egg.

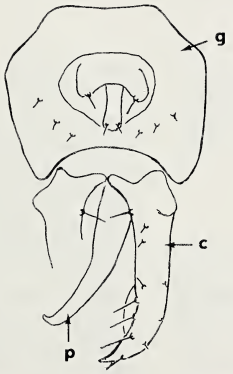
Pupal case (figs. 10-14)
Colourless. Surrounded by waxy palisade, covered with thin layer of wax. Pupal case varies in size, shape and in length of submedian setae, depending on host plant. Length usually 750-1020 µm; breadth 475-700 µm; on densely hairy leaves (*Rubus caesius* L., Bulgaria) much smaller: length 650-850 µm; breadth 375-550 µm. Shape normally oval, on hairy leaves often strongly emarginated.

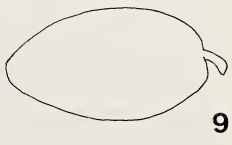
Dorsum. Margin evenly deflexed. Real margin with a smooth or crenulate appearance; apparent (visible) margin crenulate, 12-18 marginal crenulations in 100 µm (fig. 11). Tracheal combs with three to eight teeth (figs. 12, 14). Setae along submargin always minute. Eight abdominal setae always small; cephalic, first abdominal and caudal setae variating in length: as in fig. 10 but mostly longer, in specimens on *R. caesius* up to 175 µm. Segment 7 shorter than segment 6 medially: as short as in fig. 10 or much shorter and entirely filled with pockets. Median tubercle always present on segment 8 although sometimes faint. Subdorsum granulated as in fig. 11 or set with subcircular tubercles.

Venter. Legs rounded; antennae short; all spiracles present. Cephalic, 2nd and 8th abdominal setae present. Tracheal folds absent.

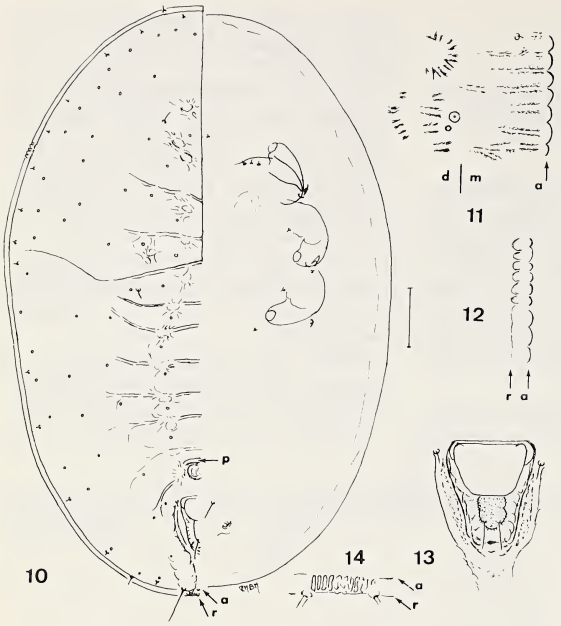
Variability. Most populations show a con-







Figs. 5-9. *Bemisia tabaci* from *Euphorbia* sp., France. 5, antenna of male; 6, male genitalia dorsal view; 7, female genitalia and chitinous press; 8, constriction of compound eye: leftside anterior part; 9, egg. c = clasper; cp = chitinous press;; d = dorsal or inner valve; g = genital plate; l = lateral or outer valve; p = penis.



Figs. 10-14. *Neopealius rubi* syntype from *Rubus* sp., Japan. 10, pupal case with deflexed margin unfolded: leftside dorsum, rightside venter; 11, submarginal and subdorsal sculpturing; 12, thoracic tracheal comb; 13. vasiform orifice; 14, caudal area with tracheal comb. a = apparent (visible) margin; d = subdorsum; m = submargin; p = pocket; r = real margin (drawn to same scale as figs. 2-4, scale pupal case 100 µm).

siderable variation as described above. The specimens from *R. caesius* are rather uniform in possessing emarginations, long submedian setae and a subdorsum with subcircular tubercles.

Adult (figs. 15-18)

Colourless or yellowish, tip of rostrum dark brown. Length without antennae: male about 1500 µm; female about 1750 µm. Length antennae male about 400 µm; female about 450 µm. Antennae similar in both sexes. Third segment longest; fourth segment shortest; segments 5 to 7 subequal in length. Segment 3 with two rhinaria and spine-like sensorium apically; segment 5 with rhinarium apically; segment 6 with spine-like sensorium apically; segment 7 with spine-like sensorium and a rhinarium halfway between spine-like sensorium and apex (fig. 15); sometimes either spine-like sensorium or rhinarium on segment 7 doubled. Compound eyes constricted to two ommatidia (fig. 18); ommatidia in anterior part slightly larger than in posterior part and after bleaching slightly brownish in exterior rows. Claws and paronychium subequal in length; paronychium hairy and with a stout seta. Sensory seta on last tarsal segment present. Wings male: length forewing about 1100 µm; hindwing about 950 µm; female: forewing about 1250 µm; hindwing about 1100 µm. Wax plates male 100-125 µm broad, about 60 µm long, distance between rows of plates about 90 µm; wax plates female about 180 µm broad, about 95 µm long, distance between plates about 90 µm. Vasiform orifice subcircular; transverse operculum with pair of posterior setae.

Male genitalia. Genital plate much broader than long. Claspers about twice as long as genital plate. Innerside of claspers with long slender setae varying in number, around and posterior to membranous area and one setae near base; several shorter setae scattered over claspers. Penis about two thirds the length of claspers (fig. 16).

Female genitalia. Inner chitinous press

about 180 µm long. Valves about 100 µm long; dorsal valve with a pair of setae, one sometimes doubled. Lateral valves with two long setae half-way and two or three long setae on hairy anterior part (fig. 17).

Material studied

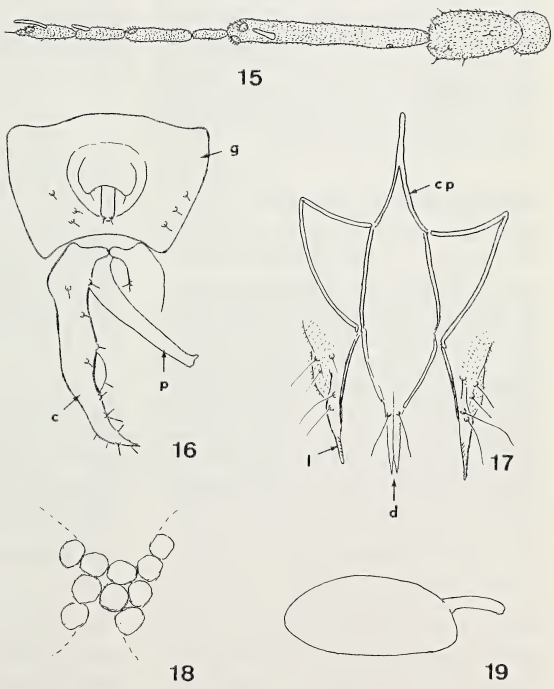
Japan: Mt Takao near Tokyo, 30.vii.1949, 6 pupal cases labelled types on *Rubus*, R. Takahashi (KU); Bulgaria: Varna, 11.ix.1979, 21 pupal cases, 2 female, 4 male adults on *R. caesius* L., F. A. Bink (CB); Bebrevo, 13.ix.1979, 20 pupal cases on *R. fruticosus* L., F. A. Bink (CB); France: Barjac, 9.ix.1980, 1 pupal case on *Acer campestre* L., F. A. Bink & R. M. Bink-Moenen (CB); Roussillon, 20.ix.1987, 4 pupal cases on *Rosa* cv, F. A. Bink & R. M. Bink-Moenen (CB); Forêt de St. Germain near Paris, 27.ix.1978, 24 pupal cases on *R. fruticosus*, F. A. Bink & R. M. Bink-Moenen (CB); Sarraud, 19.ix.1987, 13 pupal cases on *R. ulmifolius* Schott, F. A. Bink & R. M. Bink-Moenen (CB); Roussillon, 20.ix.1987, 2 female, 1 male adult on *R. ulmifolius*, F. A. Bink & R. M. Bink-Moenen (CB); Fontaine de Vaucluse, 21.ix.1987, 1 male adult on *R. caesius*, F. A. Bink & R. M. Bink-Moenen (CB); Hungary: Köszeg, 1939, 1 pupal case on *Euonymus europaeus*, A. Visnya (HNH); Köszeg, 19.x.1940, 1 pupal case on *Clematis vitalba* L., A. Visnya (HNH); Köszeg, 1940, 1 pupal case on *R. caesius*, A. Visnya (HNH); Zalaegeiszeg Ján-Ká'-teto, 13.xi.1939, A. Visnya (HNH); Poland: Kampinoska, 26.viii.1977, 45 pupal cases, 4 female adults on *R. fruticosus*, F. A. Bink & R. M. Bink-Moenen (CB).

Distribution

Japan, U.S.S.R., Hungary, Finland, Poland, France and Bulgaria (fig. 1).

Host plants

Aceraceae: *Acer campestre* (CB)
Celastraceae: *Euonymus europaeus* (HNH)
Labiatae: *Nepeta rugosa*, *Phlomis* sp. (Danzig, 1966)
Lauraceae: *Lindera obtusiloba*, *L. umbellatum* (Takahashi, 1954)



Figs. 15-19. *Neopealius rubi* from *Rubus* sp., France. 15, antenna male; 16, male genitalia dorsal view; 17, female genitalia and chitinous press; 18, constriction of compound eye: left-side anterior part; 19, egg. c = clasper; cp = chitinous press; d = dorsal or inner valve; g = genital plate; l = lateral or outer valve; p = penis (drawn to same scale as figs. 5-9).

Leguminosae: *Lespedeza buergeri* (Takahashi, 1954)
Ranunculaceae: *Clematis vitalba* (Korobitsin, 1967)
Rosaceae: *Rosa canina* L., *Rosa* sp. (Korobitsin, 1967); *R. exae*, *R. maracandica* (Danzig, 1969); *R. dumalis* Bechst., *R. pimpinellifolia* L., *Rosa* cv (Huldén, 1986); *Rubus caesius* (Korobitsin, 1967); *R. microphyllus* (Takahashi, 1954); *R. fruticosus* L., *R. ulmifolius* (CB).

Biology

Probably continously breeding mostly on lower side of leaves. Huldén (1986) expected one generation a year for Finland. In Finland puparia have been observed in July and August, while the adults disappeared during August. In the Crimea, Korobitsin (1967) observed eggs from half July to half August. Information about overwintering of *N. rubi* is lacking. Most female adults collected late in season, contained fully developed eggs. Because their host plants are deciduous in some regions, either the pupal case or the adult overwinters, as the adult is the only stage which is able to move to the young leaves.

Taxonomics status of *Neopealius*

Takahashi (1954) separated *Neopealius* from *Bemisia* by the following characters of the pupal case: "knobbed part of the lingula globular and absence of tracheal folds". Huldén (1986) who considered the material collected in Finland and U.S.S.R. as belonging to the genus *Bemisia*, gave the following characteristic of *Bemisia* based on the key of Sampson & Drews (1956), "margin with vertical wax palisade, caudal furrow present, thoracic pores and combs absent, dorsum without papillae, vasiform orifice triangular, operculum rounded". The knowledge of the genus *Bemisia* is scattered and it is far from clear if all 39 species included belong to it. However, my study of the genus so far showed that a vertical wax palisade is not a common character of pupal cases of *Bemisia* spp and is at least absent in the type-species of the genus. It could neither be derived from the key of Sampson & Drews as a character of *Bemisia* and probably resulted from misunderstanding of this key. The genus *Neopealius* includes besides the type-species one other species, which probably belongs to the genus *Pealius* Quaintance & Baker (1914). The type-species, *N. rubi*, is besides the characters given by Takahashi (1954) distinguishable from *Bemisia* by the evenly deflexed margin of the pupal case. Takahashi did not mention a wax palisade, though parts of it were present in the slide of the syntypes. The deflexed part of the submargin at the caudal area, which strongly differs by well developed ridges (fig. 14) from the remaining deflexed submargin, can also be considered as characteristic for the pupal case of this species.

The adults of the type-species of both genera are easily separated by the position of the sensoria on the last antennal segment. In *B. tabaci* both sensoria lie at a subequal distance from the apex, a feature which is constant throughout its distribution area. In *N. rubi* the rhinarium lies half-way between the spine-like sensorium and the apex of the antennae. The adults also differ in the number of ommatidia in the constriction of the compound eye: two in *N. rubi* and one in *B. tabaci*. The structural differences of the posterior and anterior parts of the compound eye, viz., colour and ommatidia size, are more pronounced in *B. tabaci* than in *N. rubi*. Genitalia of both sexes are larger in *N. rubi* than in *B. tabaci*: claspers respectively about 160 and 120 µm; chitinous press plus valves respectively about 280 and 175 µm. The inner setae on the claspers of *B. tabaci* are stout and more striking than in *N. rubi*.

In my view the adults of both species do not differ in characters which are considered important on the genus level. Though the two species differ in the number of ommatidia in the constriction, it is not known if this number is constant in the genus *Bemisia*. Adults of other *Bemisia* species have not been described or only very briefly, as is the case with the adults of most whitefly species.

The eggs do not provide many characters. The eggs of both species have a smooth surface and have about the same size. The stalk of the

eggs of *N. rubi* are twice as long as of *B. tabaci*. The impression is given by study of other whitefly species that the relative length of the stalk can be important on the genus level.

Huldén (1986) placed material of *N. rubi* in the genus *Bemisia*, in contrast to Takahashi (1954), who raised a separate genus for this species. Comparisons of the different stages of this species with those of the type-species of *Bemisia* did not provide a conclusive answer with regard to the synonymy of *Neopealius* and *Bemisia*. This is partly due to the limited knowledge of the adult stages of the whiteflies, particularly in combination with the pupal cases. For this reason it seems advisable not to change the combination *Neopealius rubi*.

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