

Morphological and cytological separation of *Amphorophora* Buckton (Homoptera: Aphididae) feeding on European raspberry and blackberry (*Rubus* spp.)

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Abstract

Aphids of the genus *Amphorophora* collected from European raspberry, *Rubus idaeus*, have a chromosome complement of $2n(\varnothing)=18$, whereas *Amphorophora* from *R. fruticosus* agg. (blackberry, brambles) have a basic chromosome complement of $2n(\varnothing)=20$. Canonical variates analysis based on eight characters measured on numerous samples of apterous virginoparae showed that *Amphorophora* on European *Rubus* can be separated morphologically into two groups consistent with the differences in host plant and karyotype, and these two groups are concluded to be separate species. The correct name for the aphid on raspberry that is a vector of European raspberry viruses is *Amphorophora idaei* (Börn.), and the species on blackberry is *A. rubi* (Kalt.). Simple biometric methods of discriminating between *A. idaei* and *A. rubi* based on pairs of variables are suggested, and their reliability is discussed. Taxonomic problems in the European and North American *Rubus*-feeding species of *Amphorophora* are considered with particular reference to their importance in applied entomology.

Introduction

The presence of a distinct, large, green species of aphid on raspberries was first noted by Joshua Major (1829), who stated that it was 'considerably larger than any yet described. It is very active and appears alarmed when anything approaches it. It reigns principally in July when the first fruit is ripe, a time that would be improper to apply anything for its destruction.' Kaltenbach (1843) provided a valid name (*Aphis rubi*) and a formal description distinguishing the large greenfly occurring from June to September on *Rubus* species (*caesius*, *corylifolius*, *fruticosus*, *discolor*, *idaeus*, etc.) from greenfly on other plants. Schouteden (1906) transferred *Aphis rubi* Kaltenbach to *Amphorophora* and since then all large green aphids with clavate siphunculi on *Rubus* in western Europe have generally been regarded as the one species, *Amphorophora rubi* (Kaltenbach).

Börner (1939), however, decided on the basis of host-plant transfers and morphological studies that there were two distinct *Rubus*-feeding species of *Amphorophora* (although he used the generic name *Nectarosiphon*); one feeding on *R. idaeus* (European raspberry), which he called *idaei*, and the other on *R. caesius*, *R. fruticosus* agg., etc., which he regarded as the true *rubi* (Kaltenbach). The characters he gave for distin-

guishing the two species were colour, numbers of rhinaria on the third antennal segments of alatae and apterae, and number of caudal hairs. Börner's separation has not been widely accepted. Hille Ris Lambers (1949) in his account of western European *Amphorophora* said of *rubi* and *idaei* (p. 241): 'It appears from my material that none of the characters (given by Börner) holds, although this does not prove that the two forms are identical.' Hill (1953) examined numerous *Amphorophora* from wild *R. fruticosus* (bramble) in Scotland and apparently compared them morphologically with aphids from raspberry (although this is not clear from his paper), but found no evidence to convince him that two species were present.

Briggs (1959) regarded Börner's aphid from *R. caesius* as a 'strain' of *A. rubi*, treating it as equivalent to other strains of *Amphorophora*, which are important as vectors of raspberry viruses. In a later paper, Briggs (1965) postulated single gene differences between 'strains' colonising different raspberry varieties, but did not refer again to the possible genetic relationship between raspberry- and blackberry-feeding *Amphorophora*.

Thus the taxonomy of *Amphorophora* on *Rubus* in Europe has remained confused and the raspberry- and blackberry-feeding forms are generally regarded as host-plant races, or at most, subspecies, of the one species, *A. rubi*. This leaves unanswered the important question of whether wild brambles can provide a natural reservoir for aphids carrying raspberry viruses.

Preliminary morphological comparison of *Amphorophora* from raspberries and blackberries in the British Museum (Natural History) collection indicated slight but consistent differences in the ranges of certain characters, particularly those used by Börner to separate *rubi* and *idaei*. For example, alate specimens from *R. fruticosus* have 41-83 rhinaria on the third antennal segment at a density of 44-69 per mm in May, 36-65 per mm in June, and 30-56 per mm in July-August. Alate specimens from *R. idaeus* have 23-60 rhinaria on the third antennal segment at a density of 34-49 per mm in June and 22-47 per mm in July. A more detailed biometric and cytological study was therefore undertaken to clarify the taxonomic relationship between the two forms and to find reliable characters by which to distinguish them.

Materials and methods

For cytological studies, embryos were dissected out of immature apterous virginoparae in 0.75% potassium chloride solution and fixed immediately in 3:1 methanol/acetic acid. The smallest embryos were transferred to a drop of 45% propionic acid on a clean microslide and squashed under a cover-slip. After preliminary examination by phase contrast the preparations were made permanent by freezing off the cover-slip, air-drying and staining in Giemsa (10% in phosphate buffer at pH 6.8).

The biometric study was based solely on the most commonly found morph, the apterous virginopara. Eight characters were used, which were chosen from preliminary studies as the most likely to show differences between the raspberry and blackberry forms of *Amphorophora*. These were:

1. Body length (from tip of antennal tubercle to tip of sub-anal plate).
2. Length of siphunculus.
3. Length of cauda.
4. Length of third antennal segment.
5. Length of processus terminalis of sixth antennal segment.
6. Length of ultimate rostral segment (Fig. 1).
7. Length of second segment of hind tarsus.
8. Number of hairs on cauda.

The study material comprised 34 clones and 11 non-clonal field-collected samples. Twenty-six clones were started from single virginoparae collected on *R. fruticosus*, and eight from single aphids collected on *R. idaeus*, all from different localities in

