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Toward an Understanding of Host Plant Associations of Whiteflies (Hemiptera: Aleyrodidae): An Evolutionary Approach 【Scientific note】

從進化觀點看粉蝨與寄主植物之關係【科學短訊】

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Abstract

An analysis of host plant-whitefly associations suggests that the whitefly subfamily, Aleurodinae, was the first to achieve success with feeding on gymnosperms and surviving than in the Aleurodicinae. This analysis opens a new avenue for research: Why are gymnosperms not favored by the Aleurodicinae? Further, the whitefly subfamily, Aleurodicinae, was not found to feed on Pteridophyta. Both subfamilies of whiteflies prefer dicotyledons (dicots) to monocotyledons (monocots), and a maximum of fabaceaeous hosts occurs in dicotyledons and the Graminae in monocotyledons.

摘要

依據粉蝨種類與寄主植物關係：粉蝨亞科 (Aleurodinae) 早於複孔粉蝨亞科 (Aleurodicinae)，可以在裸子植物 (gymnosperms) 上取食存活。此分析提供另一研究方向：為何複孔粉蝨亞科無法在裸子植物上存活？再者，此亞科亦無法在蕨類植物 (Pteridophyta) 上存活？粉蝨的兩亞科均喜好雙子葉 (dicotyledons) 更甚於單子葉植物 (monocotyledons)；並且取食雙子葉豆科 (Fabaceae) 以及單子葉禾本科植物 (Graminae) 的粉蝨種類最多。

Key words: Hemiptera, Aleyrodidae, whiteflies, subfamily, host plants

關鍵詞: 半翅目、粉蝨科、粉蝨、亞科、寄主植物

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Toward an Understanding of Host Plant Associations of Whiteflies (Hemiptera: Aleyrodidae): An Evolutionary Approach

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ABSTRACT

An analysis of host plant-whitefly associations suggests that the whitefly subfamily, Aleurodinae, was the first to achieve success with feeding on gymnosperms and surviving than in the Aleurodicinae. This analysis opens a new avenue for research: Why are gymnosperms not favored by the Aleurodicinae? Further, the whitefly subfamily, Aleurodicinae, was not found to feed on Pteridophyta. Both subfamilies of whiteflies prefer dicotyledons (dicots) to monocotyledons (monocots), and a maximum of fabaceaeous hosts occurs in dicotyledons and the Graminae in monocotyledons.

Key words: Hemiptera, Aleyrodidae, whiteflies, subfamily, host plants

Insects are the most-dominant group of animals, and they play important roles in the functioning of ecosystems. Among the insects, whiteflies are known to occur on a variety of plants; they feed on plant sap for their development and survival, transmit viral diseases to plants, and secrete honey dew from their bodies which increases mold on plants thus hampering photosynthesis and respiration. Females usually lay eggs on the lower surface of leaves. After hatching, the nymphs cannot move to other plants but settle on the tender leaves of the same plant until they molt and become adults. Hence, the development and survival of nymphal instars are based on the host plant selected by the female. Mound and Halsey (1978) listed global host plants of whiteflies in their catalogue *Whiteflies of the World*. We have analyzed the data presented in the catalogue, with a view to shedding light on host plant preferences of whiteflies.

To analyze host plant-whitefly associations, unidentified plants and whiteflies were not included. The initial analysis was based on the total number of whiteflies recorded from plant families of the superphyla Pteridophyta and Spermatophyta which suggested that of the 164 host families, most (154) were in the Spermatophyta and the remaining ones (10) were in the Pteridophyta. These findings are very interesting in view of the distribution of the 154 host plant

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families in the phyla of gymnosperms and angiosperms within the Spermatophyta; only one family (Zamiaceae) for one species of whitefly, *Trialeurodes vaporariorum* (Westwood), is recorded from among gymnosperms, while the remaining 153 are from among angiosperms. Further, when the distributions of the 153 families of angiosperms in the subphyla Monocotyledones and Dicotyledones were analyzed, the results suggested that dicotyledons (136) were favored over monocotyledons (17) (Fig. 1). Further analysis of the data to determine the maximum numbers of host plant genera recorded for monocots and dicots was carried out. The analysis of the generic distribution of host plants of whiteflies indicated that most genera belonged to the Fabaceae (dicotyledons), and 25 genera were from the Graminae (monocotyledons); this suggests that whiteflies prefer fabaceaeous hosts. Generic level analysis of host plant preferences of the whitefly subfamily Aleurodicinae indicated their occurrence on 19 genera of monocots and 94 genera of dicots (both of which include an unidentified genus) within the angiosperms (Fig. 2). This suggests that members of the Aleurodicinae prefer dicots over monocots. Analysis of the number of whiteflies known from only a single host and more than one host suggested that only 31 whiteflies were recorded from a single host family, and the 133 whiteflies with more than one host suggested that having larger host ranges of species or subfamilies is not due to the number of species but is due to the host plant selection capacity of individual species (Fig. 3). This also suggested that larger host ranges among dicots are not due to polyphagous species.

An analysis was carried out on host plant associations based on whitefly subfamilies recorded from the Pteridophyta and Spermatophyta to ascertain whether both subfamilies of whitefly occur with the same patterns on the Pteridophyta and Spermatophyta. The analysis indicated that of the two subfamilies of whiteflies, only the Aleurodinae (on 10 host plant families) was recorded from the Pteridophyta while the Aleurodicinae (0)

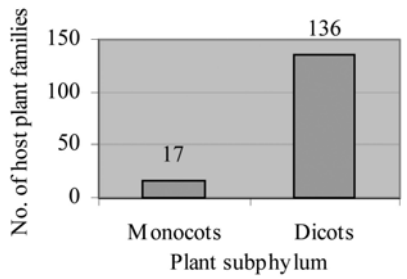

Fig. 1. Distribution of the maximum number of host genera in monocots and dicots.

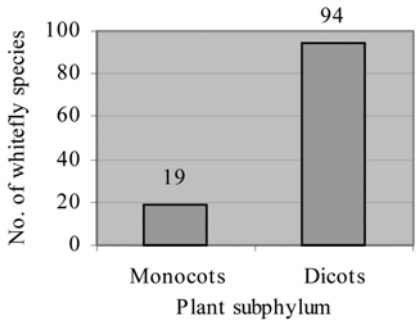

Fig. 2. The Aleurodicinae on angiosperm host plants.

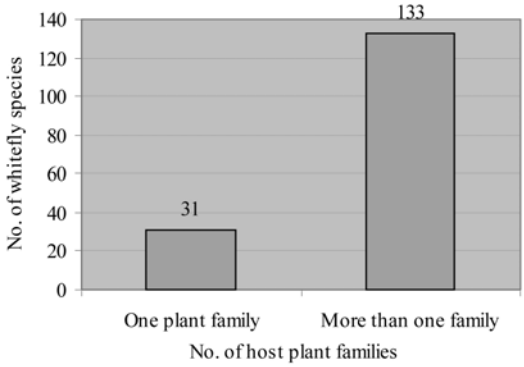

Fig. 3. Number of whitefly species for which one whitefly is known from only one host plant.

was not found to feed on the Pteridophyta (Fig. 4). In the Spermatophyta, the Aleurodicinae was recorded from 35 angiosperm families but was not recorded from gymnosperms; the Aleurodinae was recorded from 153 families, including 35 families on which the Aleurodicinae are known to occur, and also one gymnosperm family, the Zamiaceae (genus *Dioon*) (Fig. 5). There is only one record of a whitefly from a gymnosperm fern, and species which are associated with ferns are undoubtedly not primitive. It is likely that the Aleyrodidae did not evolve until after the radiation of angiosperms, but the present-day host plant relationships do not shed any light on this evolution. The subfamily Aleurodicinae, which is found mainly in South America, is usually regarded as being more primitive than and more widespread than the subfamily Aleurodinae. The main reason for this is that the Aleurodicinae has less-reduced wing venation than that of the Aleurodinae (Mound and Halsey, 1978). However, Schlee (1970) concluded that the wing venation of aleyrodids provides no evidence for kinship relations within the family. This analysis provides no information on the primitiveness of the subfamilies of the Aleyrodidae, but it can be concluded that the Aleurodinae was the first to achieve survival success by feeding on gymnosperms, as there is no record of the Aleurodicinae from gymnosperms, and there is no record of any host plant superphylum known only for one subfamily of the Aleyrodidae. It can also be concluded that the Aleurodinae is able to feed on hosts on which the Aleurodicinae is breeding (Fig. 5). The Aleurodinae has a broader host range than the Aleurodicinae because of the host plant selection capacity of individual species and because of the greater number of species described in the Aleurodinae (1010) (Fig. 6). Both subfamilies of whiteflies generally prefer dicots to monocots and fabaceaeous hosts over others. Generic

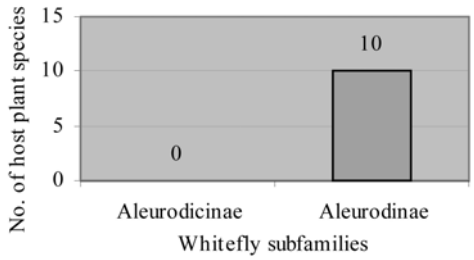

Fig. 4. Distribution of whitefly subfamilies.

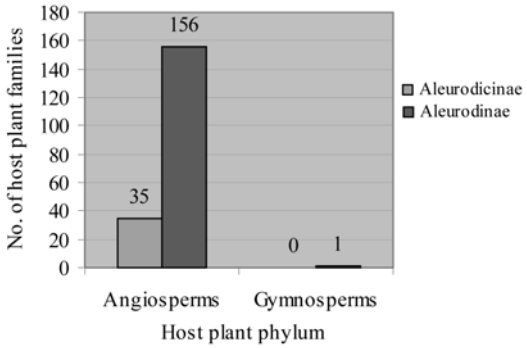

Fig. 5. Number of host plant families and records of whitefly subfamilies from the Spermatophyta.

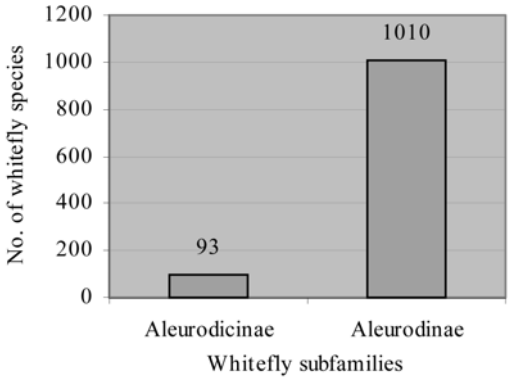

Fig. 6. Number of whitefly species in each subfamily.

level analysis of host plant preferences in the Aleurodicinae indicated their preference towards dicots rather than monocots. The above analyses addressed the need for further investigation: Why are gymnosperms

not favored by the Aleurodicinae? To determine the host plant selection mechanism in females, information on chemical ecology is needed. It should also be emphasized that a study of adult morphology to determine the phylogenetic relationships and co-evolution of plants is needed.

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從進化觀點看粉蝨與寄主植物之關係

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摘　要

依據粉蝨種類與寄主植物關係：粉蝨亞科 (Aleurodinae) 早於複孔粉蝨亞科 (Aleurodicinae)，可以在裸子植物 (gymnosperms) 上取食存活。此分析提供另一研究方向：爲何複孔粉蝨亞科無法在裸子植物上存活？再者，此亞科亦無法在蕨類植物 (Pteridophyta) 上存活？粉蝨的兩亞科均喜好雙子葉 (dicotyledons) 更甚於單子葉植物 (monocotyledons)；並且取食雙子葉豆科 (Fabaceae) 以及單子葉禾本科植物 (Graminae) 的粉蝨種類最多。

關鍵詞：半翅目、粉蝨科、粉蝨、亞科、寄主植物。