INSECT ASSOCIATES OF *GINKGO BILOBA*[1]

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ABSTRACT: Biological notes are given for the insect species collected on *Ginkgo biloba* trees in nurseries and ornamental plantings in Pennsylvania and the Charlotte, North Carolina area during 1971-72. The few plant-feeding insects found breeding on ginkgo are all known as polyphagous species; the predator fauna was also poorly developed. As an introduced species without any close relatives in North America, it is not surprising that ginkgo has failed to acquire an extensive fauna. However, even in its native habitat of eastern Asia, ginkgo has no known insect specific to it. Apparently no intimate herbivore-host relationship has evolved. This relative immunity to insect injury perhaps has aided the survival of this ancient tree species.

DESCRIPTORS: *Ginkgo biloba,* insect associates, polyphagous species, depauperate fauna, Pennsylvania, North Carolina.

Coadaptation between insects and their plant hosts has resulted in intimate plant-insect relationships and complex interactions (Ehrlich and Raven, 1965; de Wilde and Schoonhoven, 1969; Whittaker and Feeny, 1971; Root, 1973). It is common knowledge that some trees harbor large numbers of insect species, and others comparatively few (Southwood, 1960a); most vascular plants have developed a characteristic fauna and are subject to insect attack. However, *Ginkgo biloba* L., a deciduous gymnospern and sole survivor of the family Ginkgoaceae, has a depauperate fauna and often is cited as being unusually free from insect injury (Herrick, 1935). In the words of Li (1956), ginkgo "defies the scourge of all pests." In Japan its leaves have been used as an insecticide (Franklin, 1959), but Hartzell and Wilcoxon (1941) and Heal et al. (1950) did not find evidence for insecticidal activity. Recently, Major (1967) reported that the production of 2-hexenal by damaged leaves may provide some resistance to insect attack.

Ginkgo in its native habitat of eastern Asia (Franklin, 1959) is fed on by 2 species of scale insects, a tiger moth, a silkworm, and a looper (Hase, 1955). This tree was introduced as an ornamental into the Philadelphia area during the late 18th century (Franklin, 1959), and in North America certain polyphagous insects have become occasional pests: grape mealybug, *Pseudococcus maritimus* (Ehrhorn); peach lecanium, *Lecanium persicae* (F.); white-marked tussock moth, *Hemerocampa leucostigma* (J.E. Smith); omnivorous looper, *Sabulodes caberata* (Guenée); and fruittree leafroller, *Archips argyrospilus* (Walker) (Herrick, 1935; Pirone, 1970). In addition, Dekle

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[1] Accepted for publication: December 3, 1974.

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(1965) listed ginkgo as a host of several scale insects, and recently the zebra caterpillar, *Ceramica picta* (Harris), was reported to defoliate small trees in a nursery (Coop. Econ. Ins. Rept., 1973). Major and Tietz (1962) noted that Japanese beetles, *Popillia japonica* Newman, fed slightly on leaves of ginkgo when trees were in direct sunlight.

This paper summarizes observations of insects associated with *Ginkgo biloba* made while studying species on other ornamentals. Predators collected as adults only and other species thought to be of accidental occurrence have been omitted. Most of the observations were made on trees and seedlings in nurseries and landscape plantings in Pennsylvania during 1971-72. A few records from 1971 in the Charlotte, North Carolina area are included. All localities are in Pennsylvania except those labeled "Charlotte" or "Monroe, N.C."

ORTHOPTERA

Gryllidae

Oecanthus nigricornis Walker – Last-instar nymph 19 Aug., Fairview; last instar 25 Aug., Manchester.

DERMAPTERA

Forficulidae

Forficula auricularia L. – Adult under bark 4 Aug., Harrisburg.

PSOCOPTERA

Caeciliidae

Caecilius sp. – Nymph on dead, fungus-covered leaves 11 Aug., Charlotte, N.C.
Graphopsocus cruciatus (L.) – 1 ♀ taken with above.

Ectopsocidae

Ectopsocus meridionalis Ribaga – 8 ♀♀, 6 nymphs on dead fungus-covered leaves 5 Aug., Manchester; 1♀ 12 Aug., Charlotte, N.C.

Ectopsocopsis cryptomeriae (Enderlein) – 1♀, Manchester and 1♂, Charlotte, N.C., same data as *Ectopsocus meridionalis.*

Psocidae

Blaste sp. prob. *quieta* (Hagen) – 1♂ 5 Aug., Manchester.
Metylophorus novaescotiae (Walker) – 1♀ 11 Aug., Charlotte, N.C.

HEMIPTERA – HETEROPTERA

Pentatomidae

Podisus maculiventris (Say) – Eggs on leaf 22 June, Johnstown; eggs, and adult found feeding on meadow spittlebug, *Phalaenus spumarius* (L.), 5 Aug., Manchester; adult and nymph 18 Aug., Butler.

Miridae

Lygus lineolaris (Palisot de Beauvois) – 2 adults, 2 nymphs on seedlings 8 June, near Indiana; probably accidental on ginkgo.

Anthocoridae

Xylocoris sp. – Fifth-instar nymph under bark 11 Aug., Charlotte, N.C.

HEMIPTERA – HOMOPTERA

Diaspididae

Lepidosaphes ulmi (L.) – Several ♂♂ and ♀♀ 16 June, Harrisburg; eulophid wasp *Aphytis mytilaspidis* (Le Baron) reared from scales collected at same locality on 6 and 16 July. Oystershell scale is known from more than 100 tree species (Baker, 1972), but apparently has not been reported from ginkgo.

Pseudococcidae

Pseudococcus maritimus (Ehrhorn) – Nymphs in leaf axils 16 June, 26 Aug., Harrisburg. Grape mealybug is also known from more than 100 hosts (Neiswander 1949) and has been reported from ginkgo (Herrick, 1935).

Flatidae

Metcalfa pruinosa (Say) – Nymph 15 July, Manchester; adult, several cast nymphal skins 18 Aug., Butler.

Cicadellidae

Graphocephala coccinea (Forster) – 2 adults 17 Aug., Stroudsburg; adult 18 Aug., Butler; adult 20 Aug., Meadville; 7 adults 25 Aug., Manchester.

NEUROPTERA

Chrysopidae

Chrysopa oculata Say – Eggs and adult 5 Aug., Manchester.

COLEOPTERA

Melandryidae

Symphora flavicollis (Haldeman) – pupa in dead twig 13 May, Stroudsburg.

Anthicidae

Anthicus scabriceps LeConte – 2 adults in dead stem 19 Aug., Fairview.
A. virginiae (Casey) – 2 adults in dead stem of seedling 24 Sept., Indiana.

Cryptophagidae

Toramus pulchellus (LeConte) – Adult in dead stem of seedling 24 Sept., Indiana.

Coccinellidae

Coccinella transversoguttata Faldermann – 2 adults on seedlings 8 June, Indiana; pupa 19 Aug., Fairview.

Coleomegilla maculata (De Geer) – same data as *C. transversoguttata.*

Cycloneda munda (Say) – Adult (parasitized by *Perilitus coccinellae*) and pupa 18 Aug., Butler.

Hippodamia convergens Guérin – Adult 5 Aug., Manchester; pupa 19 Aug., Fairview.
Olla abdominalis (Say) – 2 adults, 1 pupa 17 June, Charlotte, N.C.; 2 adults 13 Aug., Monroe, N.C.
Psyllobora vigintimaculata (Say) – Pupa 12 Aug., Charlotte, N.C.

Phalacridae
Acylomus ergoti Casey – Adults on dead, fungus-covered leaves 5 Aug., Manchester.

Orthoperidae
Orthoperus sp. prob. *glaber* (Le Conte) – Adults on dead leaves 5 Aug., Manchester; larvae on dead, fungus-covered leaves 12-13 Aug., Charlotte, N.C.; adult 25 Aug., Manchester.

Lathridiidae
Melanophthalma distinguenda (Comolli) – Adults, larvae on dead, fungus-covered leaves 5 Aug., Manchester; adult 18 Aug., Butler; larvae on fungus-covered leaves 12 Aug., Charlotte, N.C.
M. pumila (Le Conte) – Larvae on fungus-covered leaves 12 Aug., Charlotte, N.C.

Mycetophagidae
Litargus nebulosus Le Conte – Adult in crevice of bark 4 Aug., Harrisburg.

LEPIDOPTERA

Arctiidae
Spilosoma virginica (F.) – Several egg masses, groups of larvae and feeding damage on leaves 19 Aug., Fairview.

Noctuidae
Agrotis ipsilon (Hufnagel) – Egg mass on leaf 28 July, Lancaster Co.; reared to maturity on ginkgo in laboratory, but in nature larvae probably would have dropped to ground to feed.
Ceramica picta (Harris) – Egg mass on seedling 8 June, Indiana; reared to maturity on ginkgo in laboratory; reported from ginkgo (Coop. Econ. Ins. Rept., 1973).
Peridroma saucia (Hübner) – Egg mass 8 July, State College; reared to maturity on ginkgo in laboratory.
Prodenia ornithogalli Guenée – 4 larvae, feeding damage 12-13 Aug., Charlotte, N.C.

Lasiocampidae
Malacosoma americanum (F.) – Larva 27 May, State College; 2 cocoons 8 June, numerous cocoons 23 June, Indiana; 2 egg masses 22 June, Johnstown. Occurrence on ginkgo may be accidental.

Geometridae
Anavitrinella pampinaria (Guenée) – Larva feeding on leaves 13 Aug., Charlotte, N.C.
Biston cognataria (Guenée) – Larva 17 June, Charlotte, N.C.; larva 18 Aug., Butler.

Lymantriidae
Hemerocampa leucostigma (J.E. Smith) – Early-stage larva 22 June, Johnstown; 1 early-and 1 late-stage larva 12-13 Aug., Charlotte, N.C.; several larvae 18 Aug., Butler;

egg masses, several groups of early-stage larvae and feeding damage 19 Aug., Fairview. The whitemarked tussock moth, a general feeder on deciduous and coniferous trees (Baker, 1972), is known to feed on ginkgo (Pirone, 1970).

Psychidae

Thyridopteryx ephemeraeformis (Haworth) – 6 larvae in small bags on undersides of leaves 16-20 June, Harrisburg; 3 larvae, feeding damage 22 June, Johnstown; larva 25 June, nr. Carlisle; larvae common on small trees in nursery 15 July, Manchester; larva 3 Sept., Ephrata; 3 larvae, damage 30 Sept., nr. Carlisle. Although the bagworm is known from a wide range of hosts (Davis, 1964), it apparently has not been reported to feed on ginkgo. Larvae usually fed on the lower surfaces, leaving unsightly blotched areas.

Lyonetiidae

Bucculatrix sp. – Pupae on leaves 17 June, Charlotte, N.C.; pupa 12 Aug., emerged 15 Aug., Monroe, N.C.; ca. 40 pupae 17 Aug., Stroudsburg; pupa 18 Aug., Butler. Cocoons were sometimes abundant, but the relationship to ginkgo was not determined. It is possible that nearby deciduous trees had served as hosts for this *Bucculatrix* and that merely pupation had occurred on ginkgo.

Limacodidae

Sibine stimulea (Clemens) – 4-5 larvae, feeding damage 12-13 Aug., Charlotte, N.C.

Tortricidae

Archips argyrospilus (Walker) – Larvae averaged 2/tree on 16 of 20 trees (8'-10') sampled at random in street planting 27 May, State College; 2 pupae and numerous pupal cases on same trees 8 July; larva rolling leaves of seedlings in nursery 8 June, Indiana. The fruittree leafroller feeds on a wide variety of hosts (Chapman and Lienk, 1971) and has been recorded from ginkgo (Tulecke and Colavito, 1966).

A. griseus (Robinson) - Larva 29 May, State College.

Argyrotaenia velutinana (Walker) – Larva on seedling 8 June, Indiana.

Choristoneura rosaceana (Harris) – Larva on seedling 8 June, Indiana; pupa 14 June, Montoursville; larva 18 Aug., Butler. The obliquebanded leafroller is a general feeder, although the number of its primary hosts may be limited (Chapman and Lienk, 1971).

Platynota flavedana Clemens – Larva on seedling 8 June, Indiana; larva 19 Aug., Fairview.

P. idaeusalis (Walker) – Larva 15 July, Manchester.

Sparganothis sulfureana (Clemens) – Larva 18 Aug., Butler. Howard (1896) reported this species from ginkgo at Washington, D.C.

Tineidae

? Genus poss. *Opogona* sp. – 4 larvae under bark 22 Sept., Fairview.

DIPTERA

Phoridae

Phalacrotophora epeirae (Brues) – Puparia on leaf 5 Aug., Manchester; a parasite of spider eggs (Brues, 1902).

Lonchaeidae

Lonchaea sp. prob. *polita* Say – Teneral adult at base of dead seedling and numerous larvae under bark of dead seedlings 8 June, Indiana.

Chloropidae

? *Oscinella* sp. – 2nd or early 3rd-stage larvae inside dead twigs of living trees 14 April, State College; reared in laboratory with adults emerging during 1st week of May; empty puparia of probably this species in dead twigs 11 May, Stroudsburg and 31 Aug., State College.

Sarcophagidae

Sarcophaga houghi Aldrich – Numerous larvae in old cocoons of *Malacosoma americanum* collected 23 June, Indiana.

HYMENOPTERA

Braconidae

Perilitus coccinellae (Schrank) – Emerged from coccinellid *Cycloneda munda* collected 18 Aug., Butler.

Ichneumonidae

Itoplectis conquisitor (Say) – Emerged from tortricid larva collected 18 Aug., Butler.
Zatypota cingulata Townes – Reared from cocoon collected 12 July, Harrisburg.

Eulophidae

Aphytis mytilaspidis (Le Baron) – Ex. oystershell scale, *L. ulmi,* collected 6 and 16 July, Harrisburg.

Scelionidae

Telenomus sp. – Ex. eggs of lepidopteran collected 18 Aug., Butler.

Torymidae

Monodontomerus minor (Ratzeburg) – Ex. ? bagworm, *T. ephemeraeformis,* collected 18 Aug., Butler. Known as a parasite of bagworm (Burks, 1967).

DISCUSSION

These observations on the insect associates of ginkgo support its placement among tree species most immune to insect attack (Felt, 1905; Herrick, 1935). Ginkgo does appear to be attacked rarely, and then almost exclusively by chewing insects. The only sucking species found breeding on ginkgo were oystershell scale and grape mealybug (the flatid *Metcalfa pruinosa* possibly completes its development on ginkgo). Certainly there are few other vascular plants that do not serve as host for some aphid, leafhopper, or plant bug.

Insects capable of feeding on ginkgo appear also to be generalists having a wide host plant range. Oystershell scale, grape mealybug, whitemarked tussock moth, bagworm, and fruittree leafroller all are polyphagous species.

As might be expected from the absence of a well-developed herbivore fauna, ginkgo harbors few predaceous species. Immature stages of predators

were found only rarely. Pupae of 5 coccinellid species were collected, but since larvae were never taken, development may have been completed on some other plant species.

Southwood (1960a) noted that tree species recently introduced into Britain tend to have fewer insect associates than native trees, especially those species that have been abundant throughout recent geological history. Southwood (1960b) further pointed out that introduced species that have no closely related species in the native fauna and that remain relatively rare, may have few, if any, insect associates. Since ginkgo is the sole survivor of the family Ginkgoaceae and order Ginkgoales, it is not surprising that this tree has not acquired an extensive fauna in North America. What is perhaps unusual is that no insect is known to be specific to ginkgo in its native habitat of eastern Asia. According to Hase (1955): "Wir kennen von Ginkgo keine einzige Insektenart, die daran monophag odor oligophag lebt. Auch in der Heimat in Ostasien wird Ginkgo nur von sehr polyphagen Insekten befallen." Thus no intimate herbivore-host relationship has evolved; no characteristic fauna organized around key chemicals, as in members of the Cruciferae, Umbelliferae, Solanaceae (Fraenkel, 1959), has developed.

Reasons for the survival of ginkgo are not clearly understood (Franklin, 1959), but to survive for a hundred million years, ginkgo ". . . must have come from a most tenacious stock . . ." (Li, 1956). Perhaps its relative immunity to insect attack has aided survival. This resistance to insect injury should encourage the further use of ginkgo as an ornamental plant.

ACKNOWLEDGEMENTS

B.D. Burks, R.J. Gagne', J.M. Kingsolver, P.M. Marsh, C.W. Sabrosky, G.C. Steyskal, T.J. Spilman, D.M. Weisman, and W.W. Wirth of the Systematic Entomology Laboratory, USDA, Washington, D.C.; J.G. Franclemont, Cornell University; and E.L. Mockford, Illinois State University, kindly identified specimens. I thank Heinz Wolff, a Pennsylvania Department of Agriculture regional employee, for collecting the tineid larvae. I also appreciate the help of L.L. Pechuman, Cornell University, and my colleague at the Bureau of Plant Industry, T.J. Henry in improving the manuscript.

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