Biology and Life History of *Propylea 14-punctata* (Coleoptera: Coccinellidae), an Exotic Predator of Aphids[1,2]

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ABSTRACT

Following a preoviposition period averaging 9.2 days in the laboratory, *Propylea 14-punctata* (L.) females deposited a mean of 1308 ova. Although 68% of the ova hatched, only 9.4% of them resulted in adults because of sibling cannibalism and predation by older larvae. Incubation required an average of 3.3 days, larval development, an average of 9 days; and pupal development, an average of 4.7 days. The life cycle averaged 26.2 days at 27°C. The time from ova deposition to subsequent adult emergence averaged 17 days.

Propylea 14-punctata (L.) is a common predator of aphids throughout much of Europe. It is polyphagous and occupies diverse habitats. It has been observed preying upon *Aphis fabae* Scopoli on beans, *Microsiphum evansi* (Theobald) on nettles, and *Macrosiphum solanifolii* (Ashmead) on hops in England (Banks 1955, Southey 1946); *Aphis gossypii* Glover on cotton and *Myzus persicae* Sulzer on peas in Russia (Shcheglov 1930); *Aphis pomi* De Geer and *Dentatus malicola* Mordvilko on apples in Rumania (Patrascanu 1964); *Adelges* (as *Chermes*) *piceae* (Ratzeburg) (Phylloxeridae) on fir in Austria (Schremmer 1956); and *Aphis* (as *Longiunguis*) *donacias* Passerini in France (Scharma 1966) Angalet (1965)[7] considered *P. 14-punctata* to be the most important predator of the cereal leaf beetle, *Oulema melanopus* (L.) at all locations where the predator was studied in France and Italy. While field observations of *P. 14-punctata* are recorded in European literature, detailed data on its biology are few.

Grain producers throughout the Plains States experienced severe losses in 1968 from damage by the greenbug, *Schizaphis graminum* (Rondani) on sorghum (Harvey and Hackerott 1969). Subsequently, the Insect Identification and Parasite Introduction Research Branch, Entomology Research Division, USDA, introduced *P. 14-punctata* into the United States for possible deployment against the greenbug. A few of the beetles were forwarded to the Department of Entomology, Oklahoma State University, Stillwater, for colonization and eventual field release. The original source of the coccinellid has been reported (Rogers et al. 1971). Laboratory investigations were immediately undertaken to accumulate as many biological data as possible prior to large-scale field releases. The responses of *P. 14-punctata* to the greenbug and other aphids of small grain, as well as its voracity and survival while preying upon greenbugs, are reported elsewhere (Rogers et al. 1972a, b). This paper presents the biology and life history of *P. 14-punctata* under laboratory conditions.

MATERIALS AND METHODS

P. 14-punctata adults were maintained on greenbugs infesting sorghum hybrid RS-610 enclosed within cellulose nitrate cages described by Raney et al. (1971). The cages containing paired adults were checked each day for ova. When ova were deposited on the cage wall, as was usually the case, the cage was removed and placed over another plant infested with greenbugs. When ova were deposited on the plant, the parent beetles were transferred to another caged plant infested with greenbugs. Siblings resulting from an egg mass were reared within one cage if they numbered less than 10. If more than ten 1st-stage larvae hatched per cage, the excess was transferred to another cage containing greenbugs. Mature larvae were isolated into 1-oz (29.6 ml) plastic cups to pupate. Emerging adults were sexed and either paired for laboratory studies or used in preliminary field tests.

Larval development was determined by isolating fifty 1st-stage larvae into individual 1-oz plastic cups upon eclosion and recording the time of each molt until the larvae pupate. An abundant supply of greenbugs was always available to each larva.

RESULTS AND DISCUSSION

Newly emerged females required a preoviposition period of 7–14 days ($\bar{x} = 9.2$), during which copulation was frequent and oviposition did not occur. At the end of the preoviposition period, 1–3 small egg masses were deposited at irregular intervals for a few days, after which daily oviposition was a common occurrence. Near the end of the reproductive period, egg masses were produced sporadically and contained fewer ova. One female oviposited over a period of 90 days, during which 1800 ova were deposited, but the mean was 1308 ova. The egg masses in our study contained an average of 12 ova (range 1–24), which was twice the average number of ova per mass observed by Banks (1956a) in the field. Although one female deposited 65 ova in one day, the mean was 20 ova/day.

About 68% of the *P. 14-punctata* ova were fertile.

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[7] G. W. Angalet. 1965. Natural enemies of the cereal leaf beetle *Oulema melanopa* (Linnaeus) and the related species *Oulema lichensis* (Linnaeus). Spec. Rep. P.I.-7, USDA, Agr. Res. Serv., Entomology Research Division. 16 p.

The hatch value is approximate because it represents the percent of ova producing recordable 1st-stage larvae (Rogers et al. 1972b), it was impossible to determine accurate ovum hatchability without constant surveillance and removal of 1st-stage larvae from the egg masses immediately after they hatched. Banks (1956b) observed 57 *P. 14-punctata* ova in the field, of which only 6% were infertile. However, 5.3% of the fertile ova (ova not changing color classified as infertile, while fertile ova darkened prior to hatching) were consumed by newly hatched larvae before they dispersed from the egg masses. Infertile ova were consumed also by 1st-stage larvae before dispersion occurred. This habit further reduces the prospects of accurate fertility data because it reduces the number of ova remaining in an egg mass following hatching and dispersal of the larvae. Sibling cannibalism may be an evolutionary adaption favoring survival during food scarcity. Banks (1956b) demonstrated that each newly hatched *Adalia bipunctata* (L.) larva which fed on one unhatched ovum survived twice as long as unfed larvae of the same age when no other food was available, thus the period was extended during which prey might be sought.

Of the 5372 ova observed, 3653 (68%) hatched, 529 (9.6%) developed into pupae, and 511 (9.4%) reached the adult stage. Thus it appears that larvae are even more susceptible to predation than ova. Banks (1955) reported that up to 56% of the 1st-stage coccinellid larvae in the field were destroyed by predation by older larvae. Rogers et al. (1972b) also showed that predation upon younger larvae and pupae from older larvae accounted for 84% mortality among communally reared larvae in the laboratory, compared with 5% mortality for larvae reared in isolation. Sibling predation is not unique to *P. 14-punctata*. Witter (1969) reported that *Aphidecta obliterata* (L.) larvae frequently preyed upon younger siblings undergoing ecdysis.

Adults emerged from 96.5% of the pupae. Because pupation occurred within individual containers, mortality resulted from causes other than predation. Emergence failure resulted from death of prepupae and pupae, as well as from inability of some adults to become completely disengaged from the pupal exuviae.

Larval development required a mean of 9 days. However, a few larvae completed development in 7 days, while some required 11 days. Each of the 1st 3 stadia lasted ca. 2 days. The 4th stadium lasted ca. 3 days. The 4th-stage larva (Fig. 1) is much larger and more aggressive than those in earlier stages, and consumes as many greenbugs as larvae in the 1st 3 stages combined (Rogers et al. 1972b). Patrascanu (1964) observed the development of 20–25 *P. 14-punctata* larvae and stated that duration of the larval stage varied from 9 to 18 days at 17–22.8°C.

The average time required for development from ovum to adult was 17 days. However, a few of the beetles completed development in as few as 13 days, while some required as many as 21 days. The ova hatched in 2–6 days following deposition; however, the average incubation period was 3.3 days. Pupae (Fig. 2) required more time to complete development than any other single developmental stage. The duration of the larval stage ranged from 7 to 11 days with a mean of 9 days. The pupal stadium ranged from 3 to 8 days with an average of 4.7 days. These data are similar to those reported by Patrascanu (1964). She observed an incubation period of 3–5 days at 19–24°C and a pupal duration of 4–5 days at 18–23.8°C.

A detailed study of adult longevity is reported elsewhere (Rogers et al. 1972a). The maximum adult longevity recorded in our laboratory to date has been 147 days by a female.

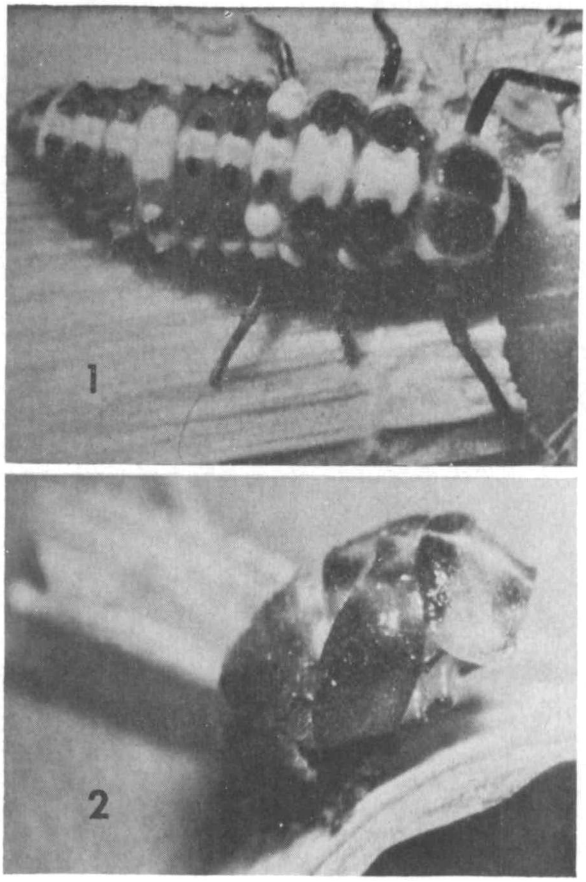

FIG. 1, 2.—*P. 14-punctata*. 1, Fourth-stage larva. 2, Pupa.

REFERENCES CITED

Banks, C. J. 1955. An ecological study of Coccinellidae (Col.) associated with *Aphis fabae* Scop. on *Vicia faba*. Bull. Entomol. Res. 46: 561–87.

1956a. Observations on the behavior and mortality of Coccinellidae before dispersal from egg shells. Proc. Roy. Entomol. Soc. London 31(4–6): 56–60.

1956b. The distributions of coccinellid egg batches and larvae in relation to numbers of *Aphis fabae* Scop. on *Vicia faba*. Bull. Entomol. Res. 47:47–56.

Harvey, T. L., and H. L. Hackerott. 1969. Recognition of a greenbug biotype injurious to sorghum. J. Econ. Entomol. 62: 776–9.

Patrascanu, E. 1964. Contributii la cunoasterea biologiei insectelor *Adalia bipunctata* si *Propylaea 14-punctata* L. Inst. Agron.'Ion. Ionescu Brad'. Iasi Lucrari Stiint. 313–21.
Raney, H. G., L. W. Coles, R. D. Eikenbary, R. D. Morrison, and K. J. Starks. 1971. Host preference, longevity, developmental period and sex ratio of *Aphelinus asychis* with three sorghum-fed species of aphids held at controlled temperatures. Ann. Entomol. Soc. Amer. 64: 169–76.
Rogers, C. E., H. B. Jackson, R. D. Eikenbary, and K. J. Starks. 1971. Sex determination in *Propylea 14-punctata* (Coleoptera: Coccinellidae), an imported predator of aphids. Ibid. 64: 957–9.
Rogers, C. E., H. B. Jackson, and R. D. Eikenbary. 1972a. Responses of an imported coccinellid, *Propylea 14-punctata,* to aphids associated with small grains in Oklahoma. Environ. Entomol. 1: 198–202.
1972b. Voracity and survival of *Propylea 14-punctata* preying upon greenbugs. Ibid. (In press.)
Schremmer, F. 1956. An infestation by *Chermes piceae* in the Wienerwald, and its natural enemies. Pflanzenschutzberichte 16: 49–69. [Rev. Appl. Entomol. 46: 200–1.]
Sharma, M. L. 1966. Contribution a l'etude de *Longiunguis donacis* (Pass.) (Aphididae-Homoptera) et fluctuation en Provence Maritime. Premiere Partie. Ann. Epiphyties 17(1): 75–128. [Rev. Appl. Entomol. 55: 613.]
Shcheglov, V. N. 1930. The effect of the damage caused by insects in the field on the household and market value of small grain. Bull. N. Caucas. Agr. Exp. Sta. BIO Rostov-on-Don. No. 310. 40 p.
Southey, J. F. 1946. A preliminary survey of the insects associated with hops in West Midlandson 1946, p. 112–6. *In* 1946 Rep. Agr. Hort. Res. Sta. Bristol. [Rev. Appl. Entomol. 37: 451–2.]
Witter, J. A. 1969. Laboratory studies on the developmental period and feeding behavior of *Aphedicta obliterata* (L.) (Coleoptera: Coccinellidae), an introduced predator of the balsam woolly aphid, Ann. Entomol. Soc. Amer. 62: 1004–8.

Interaction Between Plant Resistance and Parasitism Against the Greenbug[1] on Barley and Sorghum[2]

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ABSTRACT

Resistant varieties of barley and sorghum complemented activity of a parasite, *Lysiphlebus testaceipes* (Cresson), in reducing damage to plants and production of greenbugs, *Schizaphis graminum* (Rondani). However, the number of mummies formed by the parasite did not correspond completely to the number of greenbugs that disappeared. Resistant plants had fewer and smaller mummies compared with susceptible plants. The age of the sorghum plants made little difference in the relationship.

The greenbug, *Schizaphis graminum* (Rondani), has long been considered a chronic pest in the midwestern United States and during outbreaks has caused millions of dollars of damage to wheat, barley, rye, and oats (Dahms 1951). Then during an outbreak in 1968, a new biotype of the greenbug, the so-called sorghum greenbug or biotype C, also did considerable damage to sorghum, a crop previously considered an incidental host. Attempts to control greenbugs have included investigations of plant resistance, and we now have varieties of both barley and sorghum with comparatively high levels of resistance. Natural control has been provided by infestations of parasites and predators, especially a widely distributed native parasite, *Lysiphlebus testaceipes* (Cresson).[6]

L. testaceipes has been studied in controlled laboratory tests (Hight et al. 1972, Sekhar 1957). However, we know of no study of the effect of this parasite when it is used in conjunction with plant resistance similar to the interesting study that was done by Wyatt (1970) of the combined effect of resistant chrysanthemums plus *Aphidius matricariae* Haliday against *Myzus persicae* (Sulzer). The research reported here was an effort to study the interaction between plant resistance and parasitism by *L. testaceipes* and the effect on biotype C greenbugs.

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METHODS AND MATERIALS

All tests were done with laboratory-reared insects in a greenhouse at Stillwater, Okla., during the winter and spring of 1969–70. The temperature within the greenhouse varied between 69 and 83°F but tended to be ca. 75°F. Humidity and lighting were not measured. The sorghum and barley used in the tests were plants grown in soil, thinned to 1 plant/pot ca. 2 weeks after planting, and covered with plastic cages made with cloth-covered ventilation holes. Young adult apterous greenbugs and, 24 hr later, newly mated female *L. testaceipes,* were introduced by hand into the cages. Five tests reported here were done over a period of ca. 5 months. In all tests, measurements made were rate of reproduction of the greenbug, number of mummies produced by the parasite, and condition of the plants (rated on the basis of 0 for no greenbug damage to 5 when damage killed the plant). The data were usually recorded daily but are presented as weekly averages in the tables.