ELSEVIER

Agriculture, Ecosystems and Environment 52 (1995) 35-38

Agriculture Ecosystems & Environment

Studies on the capability of *Cheilomenes lunata* (Fabricius) (Coleoptera: Coccinellidae) to prey on the cowpea aphid, *Aphis craccivora* Koch (Homoptera: Aphididae) in Nigeria

Thomas I. Ofuya[1]

Department of Crop Production, The Federal University of Technology, P.M.B. 704, Akure, Nigeria

Abstract

Cheilomenes lunata (F.) is an important predator of *Aphis craccivora* Koch that attacks cowpeas, *Vigna unguiculata* (L.) Walpers seasonally in Nigeria. Consumption of the various instars of *A. craccivora*, by first and fourth instar larvae and adults of *C. lunata* was studied in the laboratory. The capability of the predator to suppress aphid populations on caged cowpea plants was determined. Early aphid instars were consumed in significantly greater numbers than later ones, in no-choice and free-choice trials. The population developing in 1 week from nine adult apterae of *A. craccivora* on three cowpea plants was completely controlled by a pair of *C. lunata* within the following week, the cowpea plants being infested at the seedling as well as the young pod growth phases.

Keywords: *Aphis craccivora*; *Cheilomenes lunata* (F.); Nigeria; *Vigna unguiculata*

1. Introduction

The black cowpea aphid, *Aphis craccivora* Koch is a widespread pest attacking cowpea, *Vigna unguiculata* (L.) Walpers and related grain legumes, and causing significant damage in many areas of the tropics and subtropics (Singh and Van Emden, 1979). It attacks cowpea at both seedling and post-flowering growth phases (Jackai and Daoust, 1986; Ofuya, 1989). Control of this pest through the use of insecticides (Jackai and Daoust, 1986) and host plant resistance (Ofuya, 1988; Jackai and Singh, 1988) has been investigated. Relatively little attention has been given to the natural enemies of *A. craccivora* even though these could be an important component of an integrated pest management. Several coccinellid and syrphid species have been reported as predators of the cowpea aphid in Nigeria (Booker, 1964; Don-Pedro, 1980; Ofuya, 1990). Laboratory studies (Ofuya and Akingbohungbe, 1988) have indicated that *Cheilomenes lunata* (Fabricius) was a possible candidate for the biological control of this aphid because of its positive responses to prey availability. This paper reports on two aspects of the predatory capability of this predator: (a) voracity on different *A. craccivora* stages and (b) the ability of adult predator to suppress aphid populations on cowpea, using artificial infestations in screened cages.

2. Materials and methods

The experiment used 'Ife Brown' (an aphid-susceptible cowpea variety) seedlings, laboratory colonies of

[1] Present address: Department of Biology, Royal Holloway, University of London, Egham TW20 0EX, UK.

SSDI 0167-8809(94)09006-S

A. craccivora and *C. lunata*. Therefore, routine planting of 'Ife Brown' occurred in 0.79 l plastic cups partly filled with pasteurised soil in a screenhouse (25–32°C and 50–82% relative humidity (RH)). Colonies of *A. craccivora* from field-collected individuals were established and maintained on cowpea seedlings in cages (0.6 m×0.6 m×0.9 m) in an open laboratory (23–31°C, and 54–75% RH). Ageing seedlings were regularly replaced with fresh ones. Field-collected larvae of the predator were reared to adults in glass Petri dishes (9.0 cm diameter) containing aphid-infested cowpea leaflets on moistened filter paper. Mating adults were fed in Kilner jars containing aphid infested cowpea shoot, and eggs laid were incubated in Petri dishes. All aphid transfers were made with a damp camel brush. The voracity of fourth instar larvae and adults of *C. lunata* was tested after preconditioning to standardise their hunger level. The larvae were isolated and starved for 12 h before use and at least 8 h had elapsed since the last moult. The adults were individually starved for 24 h. The larvae of *C. lunata* were supplied with aphids on fresh cowpea leaflets in 9.0 cm diameter glass Petri dishes lined with moistened filter paper. Adult males and females of *C. lunata* were provided with aphids on shoots of cowpea kept in water inside cages (13.3 cm diameter, 23.7 cm high). Fifteen replicates were made for each combination with *C. lunata* larvae and ten replicates with each sex of adults. Larvae of first, second, third and fourth instar and adult apterae of *A. craccivora* were used as prey both separately and in mixtures. In the mixtures the numbers of different prey stages were of equal proportions, the total being always 125 aphids. The number of aphids consumed in a 24 h period was recorded in the respective predatory tests.

To test the ability of the predator to suppress aphid population three potted 'Ife Brown' seedlings were placed in each of 15 cages in the screenhouse. Each seedling in ten of these cages was infested with three pre-reproductive adult apterae of *A. craccivora* when the first trifoliate leaf was fully expanded. In five cages the seedlings were not infested with aphids. After 1 week, the number of aphids in each infested cage was counted. Immediately after, five aphid-infested cages each received a 1-week-old mated pair of *C. lunata*, which had been preconditioned by starving for 24 h. The remaining five aphid-infested cages received no predators. Aphid numbers in the cages with and without predators were counted at about midday each day, when predators were usually not feeding. All plants were watered every other day, and the seed yield was recorded at harvest. A similar experiment was carried out with plants the pods of which were infested with *A. craccivora*, at the young pod growth phase of cowpea (4–7 days after flower opening).

3. Results

Table 1 gives the mean number of the various developmental stages of *A. craccivora* consumed daily by selected stages of *C. lunata* when each prey stage was offered separately. All stages of *C. lunata* consumed more first/second than third/fourth instars, which in turn suffered heavier predation than adult apterae. A similar trend was observed when the various stages were presented in a mixture to selected predator stages (Table 2).

Table 3 shows the effectiveness of a copulating pair of *C. lunata* in separately suppressing an *A. craccivora* population produced in 1 week by nine pre-reproductive adult apterae on three cowpea plants. The predator achieved complete control of the aphid in 6 days with

Table 1
Consumption by *C. lunata* of different instars of *A. craccivora* fed separately

Stage of *A. craccivora* considered	Mean number of prey consumed daily by various instars of *C. lunata* (±SE)			
	1st instar	4th instar	Adult male	Adult female
1st instar	21.4±2.16a	85.3±6.89a	90.1±7.12a	93.4±5.61a
2nd instar	19.3±1.94a	83.8±7.21a	86.7±6.78a	92.1±5.67a
3rd instar	13.1±2.33b	60.4±5.43b	64.2±6.11b	69.8±4.96b
4th instar	9.6±1.44b	54.9±5.63b	57.6±4.47b	65.4±4.96b
Adult apterae	4.7±0.91c	28.6±3.47c	34.8±2.77c	38.4±4.88c

Means within each column followed by the same letter not significantly different at the 1% level by Duncan's new multiple range test.

Table 2
Consumption by *C. lunata* of different instarts of *A. craccivora* presented in a mixture

Stage of *A. craccivora* considered	Mean percentage of prey in mixture consumed in 24 h by various stages of *C. lunata*			
	1st instar	2nd instar	3rd instar	4th instar
1st instar	56.6a	100.0a	100.0a	100.0a
2nd instar	32.4b	84.0b	100.0a	100.0a
3rd instar	8.2c	58.4c	70.7b	75.6b
4th instar	0.0d	24.8d	42.8c	54.4c
Adult apterae	0.0d	20.3d	32.4d	36.7d

Means in each column followed by the same letter not significantly different at the 1% level by Duncan's new multiple range test.

Table 3
Control of *A. craccivora* on cowpea at different phases of plant growth, nine adult apterae being placed on three plants one week before predator introduction

Treatment	Mean aphid number[a] after predator introduction						
	Day 0	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6
(A) Seedling phase							
No preddator	25.0	29.4	33.1	34.9	37.4	38.8	
With *C. lunata*	25.3	22.0	17.7	13.7	7.9	0	
(B) Young pod phase							
No predator	26.6	31.8	37.6	42.8	45.1	49.3	54.2
With *C. lunata*	26.7	24.2	21.5	18.2	14.5	9.9	0

[a] Means are square-root transformed values.

Table 4
Mean seed yield (g) of 'Ife Brown' cowpea infested at different plant growth phases with *A. craccivora*

Treatment	Seed yield (g) when infestation occurred at	
	Seedling phase	Young pod phase
Aphids with *C. lunata*	6.9b	4.9b
Aphids without *C. lunata*	0.0a	2.8a
No aphid	8.4b	8.2c

Means in each column followed by the same letter not significantly different at the 5% level by Duncan's multiple range test.

plants infested at the seedling phase, and 7 days with plants infested at the young pod growth phase. On infested plants without predators the *A. craccivora* population grew steadily. Table 4 shows that the seed yield of plants on which the predators controlled aphids at the seedling phase was not significantly ($P<0.05$) lower than in uninfested plants. Seed yield of plants on which the predators controlled aphids at the young pod growth phase was significantly ($P<0.05$) lower than that of plants free of aphids. Also, infested plants with predators had a significantly higher seed yield than infested plants without predator.

4. Discussion

Observations made on the voracity of larvae and adults of *C. lunata* are consistent with reports on other aphidiphagous coccinellids (Firempong and Kumar, 1975; Ofuya, 1986; Ng, 1991; Stadler, 1991). The number of each aphid stage consumed by the predator is determined by the defence mechanisms exhibited by the aphid. Aphid defence reactions may include kicking movements, movements of the body, pulling free the appendage seized by the predator and rapidly walking away. The younger prey stages were consumed most successfully probably because they reacted less than adult apterae of *A. craccivora*. The data also suggest that under natural conditions, the predators attack and consume younger aphid instars first, before devouring the older ones.

The rapid check achieved by a pair of *C. lunata* in a colony of *A. craccivora* on plants infested in cages supports earlier observations (Ofuya and Akingbohungbe, 1988) that *C. lunata* could be a good biological control agent for *A. craccivora*. There are several examples of successful biological control of aphids in diverse crop situations by coccinellids (Frazer, 1988; Van Lenteren, 1990; Moraal and Steingrover, 1991). The control of *A. craccivora* populations by *C. lunata* recorded here is, however, not consistent with observations of field infestation of cowpeas (Ofuya, 1991). *Aphis craccivora* and coccinellid numbers, especially larvae, show a positive linear relationship, and frequently interact beyond three weeks on infested cowpea plants. Hemptinne and Dixon (1991) suggested that the inefficiency of some aphidophagous ladybirds as biological control agents was a consequence of their ability to exploit unstable food resources. The efficiency of *C. lunata* and perhaps other coccinellid predators in suppressing *A. craccivora* populations in cowpea fields needs closer investigation. There are records of *A. craccivora* population explosions on cowpea following the use of insecticides (Don-Pedro, 1980; Ofuya, 1987), presumably because these chemicals eliminated the natural enemies of the aphid. A judicious selection and application of insecticides may be desirable to conserve these predators, and periodic releases of adults to supplement natural populations may also be needed in the field. The greater sensitivity of cowpea at the podding phase to *A. craccivora* infestation in terms of seed yield suggests that more attention is required during this period.

Acknowledgement

This study is part of an International Foundation For Science (IFS), Sweden, funded project.

References

Booker, R.H., 1964. The effect of sowing date and spacing on rosette disease of groundnut in Northern Nigeria, with observations on the vector, *Aphis craccivora*. Ann. Appl. Biol., 52:125–131.

Don-Pedro, K.N., 1980. A population explosion of *Aphis craccivora* following DDT application in a cowpea plot, *Vigna unguiculata* cultivar (Prima) in Nigeria. J. Nat. Hist., 14: 617–619.

Firempong, S. and Kumar, R., 1975. Natural enemies of *Toxoptera aurantii* (Boy.) (Homoptera: Aphididae) on cocoa in Ghana. Biol. J. Linn. Soc., 7: 261–292.

Frazer, B.D., 1988. Coccinellidae. In: A.K. Minks and P. Harrewijn (Editors), Aphids, Their Biology, Natural Enemies and Control. World Crop Pests 2b. Elsevier, Amsterdam, pp. 231–249.

Hemptinne, J.L. and Dixon, A.F.G., 1991. Why ladybirds have generally been ineffective in biological control. In: L. Polgar, R.J. Chambers, A.F.G. Dixon and I. Hodek (Editors), Behaviour and Impact of Aphidophaga. SPB Academic, The Hague, pp. 149–157.

Jackai, L.E.N. and Daoust, R.A., 1986. Insect pests of cowpeas. Ann. Rev. Entomol., 31: 95–119.

Jackai, L.E.N. and Singh, S.R., 1988. Screening techniques for host plant resistance to cowpea insect pests. Trop. Grain Legume Bull., 35:1–18.

Moraal, L.G. and Steingröver, E.G., 1991. Ladybirds for biological control of *Adelges cooleyi*, in gas exchange experiments with Douglas-fir (Coleoptera: Coccinellidae; Homoptera: Adelgidae). Entomol. Ber. Amsterdam, 51:136–138.

Ng, S.M., 1991. Voracity, development and growth of larvae of *Menochilus sexmaculatus* (Coleoptera: Coccinellidae) fed on *Aphis spiraecola*. In: L. Polgar, R.J. Chambers, A.F.G. Dixon and I. Hodek (Editors), Behaviour and Impact of Aphidophaga. SPB Academic, The Hague, pp. 199–206.

Ofuya, T.I., 1986. Predation by *Cheilomenes vicina* (Coleoptera: Coccinellidae) on the cowpea aphid, *Aphis craccivora* (Homoptera: Aphididae): Effect of prey stage and density. Entomophaga, 31: 331–335.

Ofuya, T.I., 1987. A population explosion of *Aphis craccivora* Koch (Homoptera: Aphididae) in cowpeas protected with cypermethrin. FAO Plant Prot. Bull., 35: 75–77.

Ofuya, T.I., 1988. Varietal resistance of cowpeas to the cowpea aphid, *Aphis craccivora* Koch (Homoptera: Aphididae) under field and screenhouse conditions in Nigeria. Trop. Pest Manage., 34: 445–447.

Ofuya, T.I., 1989. The effect of pod growth stages in cowpea on aphid reproduction and damage by the cowpea aphid, *Aphis craccivora* (Homoptera: Aphididae). Ann. Appl. Biol., 115: 563–566.

Ofuya, T.I., 1990. Observations on the biology of *Cheilomenes vicina* (Mulsant) (Coleoptera: Coccinellidae), a predator of the cowpea aphid, *Aphis craccivora* Koch (Homoptera: Aphididae) in Nigeria. Niger. J. Sci., 24:171–173.

Ofuya, T.I., 1991. Aspects of predation in *Cheilomenes lunata* (Fabricius) (Coleoptera: Coccinellidae) on the cowpea aphid, *Aphis craccivora* Koch (Homoptera: Aphididae) in Nigeria. Z. Angew. Zool., 78:413–419.

Ofuya, T.I. and Akingbohungbe, A.E., 1988. Functional and numerical responses of *Cheilomenes lunata* (Fabricius) (Coleoptera: Coccinellidae) feeding on the cowpea aphid, *Aphis craccivora* Koch (Homoptera: Aphididae). Insect Sci. Appl., 4: 543–546.

Singh, S.R. and van Emden, H.F., 1979: Insect pests of grain legumes. Ann. Rev. Entomol., 24: 255–278.

Stadler, B., 1991. Predation success of *Coccinella septempunctata* when attacking different *Uroleucon* species. In: L. Polgar, R.J. Chambers, A.F.G. Dixon and I. Hodek (Editors), Behaviour and Impact of Aphidophaga. SPB Academic, The Hague, pp. 265–271.

Van Lenteren, J.C., 1990. A century of biological control in West Europe. Proc. Exp. Appl. Entomol., 1: 3–12.