apices, at most ⅓ the basal diameter of antennal segment III. Siphunculi 1/6–⅕ as long as body, pale at basal 1/6–⅛, rest black, faintly imbricated, gently but distinctly swollen in the middle; diameter at the middle 1⅛–1½ times the diameter at the base and 1⅝–2 times the diameter at the apex. Cauda pale, elongate, nearly ⅔ as long as the siphunculi, with at least 3 pairs of conspicuous hairs; sometimes 1–2 short hairs may be present in addition. Femora dark brown to black on distal ¼–⅓, bearing spinulose imbrications, rest pale. Tibiae smooth, pale, darker for a short distance just after the very base and again at apical ⅓; tarsi dark brown. First tarsal segments with 3 hairs.

Measurement of Holotype in mm.—Length of body 2.3; breadth of body 1.0 mm; antenna 2.7; antennal segments III:IV:V:VI, 0.55:0.52:0.47:0.19 + 0.98; siphunculus 0.41; diameter of siphunculus at base 0.06, at middle 0.08, at apex 0.04; cauda 0.27; ultimate rostral segment 0.10; 2nd segment of hind tarsus 0.10.

Alate Viviparous Female

Morphological Characters.—Antennal segment III with 5–8 secondary rhinaria in a row, restricted to basal ⅔; antennal segment IV without any rhinaria. Forewing with media twice branched, cubitus and 1st anal veins heavily bordered fuscous. Hind wing short but with both media and cubitus. Siphunculi cylindrical and pale on basal ⅓, suddenly swollen on apical ⅔, which is black; minimum width at the junction of pale and dark parts; other characters same as apterous form.

Measurement of 1 Specimen in mm.—Length of body 2.15; breadth of body 0.83; antenna 2.25; antennal segments III:IV:V:VI, 0.48:0.47:0.45:0.16 + ? (broken); siphunculus 0.34; diameter of the siphunculus at base 0.04, at middle 0.06, at apex 0.04; cauda 0.23; ultimate rostral segment 0.10; 2nd segment of hind tarsus 0.10.

Collection.—On a plant of the Leguminosae, Nagrakata (Dooars), North Bengal, India, II–15–1964, 35 specimens. All collected by H. Mitra, Advisory Officer, Tea Research Association, Nagrakata, Dooars.

Types

Holotype.—Apterous viviparous ♀, the specimen at 3 o'clock position on a slide with 3 nymphs, Nagrakata, India, Feb. 15, 1964, on an unidentified host plant of the Leguminosae, H. Mitra coll. Collection no. 985.

Paratypes.—8 slides (nos. 983, 984, 986–990, 990a) with specimens as follows: (1) apterous viviparous ♀ and 2 nymphs; (2) 2 apterous viviparous ♀, 1 alate viviparous ♀ and 1 nymph; (3) 1 apterous viviparous ♀ and 3 nymphs; (4) 3 apterous viviparous ♀ and 1 nymph; (5) 5 apterous viviparous ♀ and 1 nymph; (6) 4 apterous viviparous ♀; (7) 1 apterous viviparous ♀ and 3 nymphs; (8) 2 apterous viviparous ♀. Collection data same as holotype. Holotype and paratypes deposited in the collection of Entomological Laboratories, Department of Zoology, University of Calcutta, India. Slide no. 990a in the collection of British Museum (Natural History), London.

Type-locality.—Nagrakata (Dooars), North Bengal, India.

Notes.—The new species comes close to *M. kislankoi* Smith & Heie (1963) but can easily be distinguished by its longer body, longer frontal hairs, number of hairs on ultimate rostral segment, coloration of antennae and siphunculi, absence of any abdominal sclerite, proportion of caudal length to the siphunculus, and nature of caudal hair.

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Studies on *Nephus regularis* (Coleoptera: Coccinellidae) as a Predator of the Striped Mealybug in Madhya Pradesh (India)[1]

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ABSTRACT

Observations on the life history of *Nephus regularis* Sicard, a predator on the striped mealybug, *Ferrisia virgata* (Cockerell), (Homoptera: Pseudococcidae) are given and include data on the duration of developmental stages, mating behavior, longevity, role in the natural control of the host mealybug, seasonal activity, and distribution in India.

Coccinellids are recognized as important predators of homopterous pests. The striped mealybug, *Ferrisia virgata* (Cockerell) (Homoptera : Pseudococcidae), is a pest of considerable importance, damaging vegetable crops and ornamental plants. It has been recorded from all over the world in tropical and subtropical regions, and it has been reported from Maryland in the United States (Highland 1956). During our studies of the natural enemies of this pest in Madhya Pradesh (India), *Nephus regularis* Sicard was recorded for the 1st time in this State and found to be the most important natural enemy of the pest (Rawat and Modi 1968). The predator was previously recorded from Mysore (Puttarudriah and Channa Basavanna 1957). Because of the absence of any detailed published work on this species, we under-

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took studies at Jabalpur during 1967–68 on its bionomics and potential capacity as a natural enemy of *F. virgata,* and our findings are reported here.

MATERIALS AND METHODS

The biology of *N. regularis* was studied under laboratory conditions from November 1967 to April 1968. During this period the average minimum and maximum temperatures ranged from 18.0 to 28.6°C and 20.5 to 32.4°C, respectively. Freshly emerged adults were confined in small petri dishes and were provided with mealybugs from a laboratory-reared culture of *F. virgata,* on *Acalypha* shoots for noting the longevity and fecundity. On hatching, predator larvae were reared individually in small glass tubes (5 × 1 cm) on early instars of the pest. Observations were recorded daily on egg laying, development, etc. For evaluation of the potential capacity of the larvae and adults to control the pest, counted numbers of different instars and adult females of the pest were provided and their total and per-day consumption were noted. Longevity of starved adults, and of fed adults when allowed to reproduce or not reproduce, was determined. Observations were made also on seasonal activity, host range, and natural enemies of the beetle.

RESULTS AND DISCUSSION

Distribution and Host Range.—Previously, Puttarudriah and Channa Basavanna (1957) reported this beetle from Mysore on the cotton aphid, *Aphis gossypii* Glover; *Phenacoccus insolitus* Green; and *Pseudococcus* sp. In Madhya Pradesh the beetle was found to attack *F. virgata* from Raipur, Rewa, and Jabalpur. Besides *F. virgata,* it was also found to be predaceous on *Centrococcus insolitus* (Green) and an unidentified scale insect infesting "coral vine," *Antigonon leptopus* Hook & Arn.

Life History.—Table 1 summarizes the durations of different developmental stages.

Egg.—Eggs are smooth, yellowish, and oblong, ca. 0.44×0.20 mm. One or 2 days before hatching, a longitudinal furrowlike cavity is formed in the eggshell as it shrinks. The average incubation period ranged from 6.3±0.3 to 8.9±0.9 days.

Larva.—Freshly hatched and fullgrown larvae measure ca. 0.72×0.24 mm and 4.40×0.85 mm, respectively. The larva is yellowish, with black ocelli. On the pronotum there is a pair of prominent black spots and behind them a pair of minute black dots. On the dorsum of the meso- and metathorax also there is a pair of similar minute black dots. The body of undisturbed larvae is covered with whitish, waxy, fluffy filaments which make larvae indistinguishable in the waxy covering of the pest colony. There were 4 larval stages, the durations of which ranged from 2.1±0.3 to 7.3±0.4, 2.0±0.2 to 3.5±0.6, 2.0± 0.3 to 3.7 to 0.4, and 2.6±0.8 to 10.5±4.8 days, respectively. The total larval period ranged from 8.9±1.1 to 23.4± 4.6 days.

Prepupa.—The prepupa measures ca. 2.20×0.80 mm. The average duration of the prepupal stage ranged from 1.5±0.6 to 4.1±1.9 days.

Pupa.—The pupa is yellowish and measures ca. 1.80×1.20 mm. Pupation occurs inside the contracted last larval skin. The average pupal period ranged from 4.5±0.5 to 11.0±1.8 days.

The average duration of total life cycle from egg to adult ranged from 18.1±1.7 days during April to 57.5±4.9 days during December and January.

Adult.—Adults are reddish brown with a dark prothoracic shield. The females are slightly larger (1.80×1.32 mm) than the males (1.64×1.24 mm).

Mating.—Mating occurred frequently and a female mated as many as 8 times throughout the reproductive phase. As seen in 15 cases, the duration of a single mating ranged from 6 to 44 and averaged 23.1 min.

Preoviposition, Oviposition, and Postoviposition Periods.—The durations of preoviposition, oviposition, and postoviposition periods ranged from 4–17 (avg 9.0), 14–52 (avg 33.1), and 0–11 (avg 3.2) days, respectively (Table 2).

Oviposition and Fecundity.—Eggs are laid either

Table 1.—Duration of development periods (in days) of *N. regularis.*

Month eggs were laid (temp °C in laboratory)	Particulars	Incubation period	Larval stages				Total larval period	Prepupal period	Pupal period	Total development (egg to adult)
			1st	2nd	3rd	4th				
	n	31	31	31	31	29	29	28	26	26
Nov. 1967	Range (mode)	5–8 (6)	2–5 (3)	2–4 (3)	2–4 (3)	4–10 (5)	13–20 (14)	2–6 (2)	8–14 (13)	31–43 (38)
(20.5–26.0)	Mean±SD	6.3±0.3	2.9±0.8	2.8±0.6	3.3±0.5	6.3±1.5	15.8±1.6	2.9±1.0	11.0±1.8	36.1±3.6
	n	20	15	14	14	13	13	11	11	11
Dec. 1967	Range (mode)	8–11 (8)	5–7 (5)	3–5 (3)	3–4 (4)	5–24 (9)	19–36 (22)	2–8 (3)	16–27 (21)	49–67 (58)
(18.0–24.5)	Mean±SD	8.9±0.9	5.6±0.5	3.5±0.6	3.7±0.4	10.5±4.8	23.4±4.6	4.1±1.9	20.8±3.1	57.5±4.9
	n	14	8	8	8	8	8	8	8	8
Feb. 1968	Range (mode)	6–11 (6)	7–8 (7)	2–3 (3)	1–3 (3)	3–7 (5)	14–20 (17)	2–3 (3)	4–6 (5)	28–37 (30)
(21.0–28.5)	Mean±SD	7.2±1.5	7.3±0.4	2.5±0.5	2.5±0.7	5.0±1.1	17.3±1.6	2.6±0.4	4.8±0.7	31.7±2.9
	n	27	13	12	12	12	12	12	12	12
Apr. 1968	Range (mode)	3–4 (3)	2–3 (2)	1–3 (2)	1–3 (2)	2–5 (2)	8–11 (8)	1–3 (1)	4–5 (5)	16–22 (17)
(25.6–32.4)	Mean±SD	3.1±0.3	2.1±0.3	2.0±0.2	2.0±0.3	2.6±0.8	8.9±1.1	1.5±0.6	4.5±0.5	18.1±1.7

Table 2. — Duration of preoviposition, oviposition, and postoviposition periods (in days), and fecundity of *N. regularis*.

Case no.	Duration of			No. eggs laid
	Preoviposition	Oviposition	Postoviposition	
1	17	52	11	164
2	9	14	4	55
3	4	35	1	384
4	8	29	0	96
5	5	45	0	263
6	11	24		96
Avg	9.0	33.1	3.2	176.3

singly or in groups, each having up to 6 eggs, in the waxy covering of the pest colony or rarely exposed on the leaf surface. The fecundity ranged from 55 to 384 (avg 176.3) eggs (Table 2).

Longevity of Adults.—Table 3 summarizes the data on the longevity of adults under different conditions of feeding and reproduction. Adult longevity was very much reduced when beetles were starved, ranging from 5 to 10 (avg 7.7) days, in comparison with longevity when food was provided regularly. Longevity differed according to whether fed adults were allowed to mate and reproduce. If allowed to mate, longevity ranged from 28 to 57 days (avg 43.6 days, ♀ ; 42.8 days, ♂). In the case of nonmated beetles, longevity was maximal, ranging from 66 to 141 (avg 113.9) days.

Potential Feeding Capacity.—Both larvae and adults feed in the pest colonies on different host instars and adult females but generally prefer early instars. The predators generally attack the prey from its ventral side and continue feeding on it till it is completely devoured.

Feeding Capacity of Larva.—The total feeding capacity of a larva in the 8- to 17-day larval period ranged from 57 to 142 1st instars (Table 4).

Feeding Capacity of Adult.—The total feeding capacity of adult beetles throughout their life ranged from 782 to 902 1st-instars, 264 to 428 2nd and 3rd instars, and 37 to 43 adult females (Table 5). The

Table 3.—Longevity (in days) of adults of *N. regularis* under specified conditions.

Case no.	Adults starved	Adults fed		
		Allowed to reproduce		Not allowed to reproduce
		Female	Male	
1	6	40	39	117
2	10	57	57	141
3	10	49	47	140
4	5	28	29	137
5	7	44	42	66
6	8			125
7				76
8				109
Avg	7.7	43.6	42.8	113.9

Table 4. — Feeding capacity of larvae of *N. regularis* on 1st instars of *F. virgata*.

Case no.	Larval period (days)	Consumption of 1st instars	
		Total	Avg per day
1	8	69	8.6
2	8	79	9.7
3	8	57	7.1
4	8	89	11.1
5	17	142	8.3
6	15	129	8.6

average per-day consumption of 1st instars by the adult beetle and the larva was thus of the same order but because the adult lived longer the total feeding capacity of adults was much greater than that of larvae. These findings show that *N. regularis* is an important agent in the natural control of the pest.

Seasonal Activity.—The beetle was found active throughout the year but was most active and abundant during September–December and March–April, corresponding with the active periods of the host, *F. virgata*. Puttarudriah and Channa Basavanna (1957) also recorded *N. regularis* as active practically throughout the year in Mysore.

Natural Enemies.—Homalotylus quaylei Timberlake (Hymenoptera : Encyrtidae) was recorded as a larval parasite but was not of much significance in rendering the predator ineffective.

SUMMARY

N. regularis is recorded as predaceous on *F. virgata, C. insolitus,* and an unidentified scale insect on coral vine. The average duration of development from egg to adult on *F. virgata* ranged from 18.1± 1.7 days during April to 57.5±4.9 days during December–January. Eggs were laid singly or in groups in the cottony masses of the pest. Fecundity ranged from 55 to 384 eggs. Adult longevity was 5–10 days under starvation, 28–57 days with food when allowed to reproduce, and 66–141 days with food when not allowed to reproduce. The early instars of the host were found to be preferred to the other stages. The total 1st instars of *F. virgata* consumed by larvae and adults varied from 57 to 142 and 782 to 902, respectively. The predator was active throughout the year. An encyrtid parasite, *H. quaylei,*

Table 5. — Feeding capacity of adults of *N. regularis* on different stages of *F. virgata*.

Case no.	Stage of pest provided	Adult longevity (days)	Consumption	
			Total	Avg/day
1	1st instars	76	782	10.2
2	"	125	902	7.2
3	2nd & 3rd instars	140	274	1.9
4	"	66	264	4.0
5	"	137	347	2.0
6	"	141	428	3.0
7	Adult females	117	37	0.3
8	"	109	47	.4

was recorded as a larval parasite but was not of much significance.

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Mating Competition Between Eastern and Western Strains of the Alfalfa Weevil, *Hypera postica*[1,2]

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ABSTRACT

Adult *H. postica* (Gyllenhal) (Coleoptera: Curculionidae) from populations in Utah and Maryland were marked for recognition, placed in a free-choice mating situation, and observed repeatedly for 2 months. No mating preferences were shown, and eastern and western males were equally competitive in mating when they were confined with eastern females only. Sex ratios of progeny and egg hatch were essentially as expected from previous single cross matings—an increase in the ♀:♂ sex ratio of progeny from western ♀ × eastern ♂ matings and complete sterility of eggs from eastern ♀ × western ♂ matings.

It has been established (Blickenstaff 1965) that crosses between eastern (E) and western (W) U.S. strains of the alfalfa weevil, *H. postica* (Gyllenhal), were partially sterile, that is, E ♀ × W ♂ crosses produced nonviable eggs, and W ♀ × E ♂ produced viable eggs, but the progeny were predominantly female. Also, hybrids were fertile but behaved as W weevils when backcrossed.

Additional tests were made to determine: 1, mating preferences, if any, in a free-choice situation; 2, competition between males of the 2 strains confined with E females; and 3, the effect of situations involving choices on egg viability and sex ratio of progeny. On the basis of results from my previous research, if no mating preference was shown and E and W sperm were equally effective in ability to fertilize eggs, then a reduction in egg hatch and a slight excess of female progeny should occur.

METHODS

Larvae and pupae collected near Smithfield, Utah (W), were received from Donald W. Davis, Utah State University, Logan, July 16, 1964. The adults were sexed July 30 and held at ca. 23°C under an 8-hr light regimen on cut stems of alfalfa. They entered diapause and did not become sexually mature until December. Nondiapausing Maryland weevils (E) were obtained by laboratory rearing under a 14-hr light day of larvae from eggs laid by adults collected near Beltsville in late fall 1964.

In December, when the W weevils were breaking diapause and the E weevils were becoming sexually mature, they were placed together in various combinations. The tests and numbers of weevils placed in each vial were:

Treatments	E ♂	E ♀	W ♂	W ♀	No. replicates
Checks					
1	4	4			1
2			4	4	1
3		4	5		1
4	4			4	1
Group A	4	4	4	4	4
Group B	4	4	4		4

Treatments 1, 2, 3, and 4 duplicated the original crosses (Blickenstaff 1965) and served as checks. In the Group A treatment, the 16 weevils/vial had a free choice of mates, while in the Group B treatment E and W males were in mating competition for E females.

A small red or yellow spot of enamel paint was placed on the right or left elytron to indicate the origin of the weevils. To check the number and identity of mating individuals, all weevils were observed 84 times during the 7 weeks beginning Dec. 12. The numbers of times observed during each succeeding week were 7, 13, 15, 21, 15, 6, and 7.

Cut stems of alfalfa were used as food and sites for oviposition and were changed 3 times a week. The

[1] Coleoptera: Curculionidae.
[2] Accepted for publication Dec. 9, 1968.