Rec. zool. Surv. India, **85(4)** : 481-508, 1989

BIOMORPHOLOGY OF ORIENTAL APHIDIDAE-I *GREENIDEOIDA CEYLONIAE* v.d. GOOT (HOMOPTERA ; APHIDIDAE)

By

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INTRODUCTION

Greenideoida ceyloniae v. d. Goot 1917 is member of sub-family Greenideinae. Its distribution is so far restricted to Meghalaya and Tripura in India, Malaysia and Sri Lanka (Raychaudhuri, 1980) and has a specific host *Mesua ferrea*, a member of the plant family Guttifereae, which is distributed in the tropical belt of South East Asia (Deb, 1981). Ghosh (1976) recorded sexuales and the apterous viviparous morph from Shillong, Meghalaya, and Agarwala (1982) recorded the fundatrix and alate viviparous female morphs from Agartala, Tripura. Raychaudhuri (1956) provided a brief description on the apterous viviparous female and fundatrix. This species of Oriental origin was so far not studied for its seasonal preponderance and developmental morphology. Seasonal variations in various morphs were also not accounted for. This is the first investigation of a *Greenideoida* species in respect of its developmental morphology, seasonal preponderance and morph succession and distribution on the host plant. Similar study is lacking in respect of any member of the tribe Greenideini from India which is represented by 77 species including 65 endemic species.

Materials and Methods

Five plants of *Mesua ferrea* located in College Tilla, Agartala were chosen as the study site in the present investigation. Weekly observation on the population composition, morph distribution and host condition were taken between February 1983 and January 1984. Samples of aphids representing different morphs were collected each month in 70% alcohol and studied for their morphological variations. During March—April 1983, apterous and alate viviparous female morphs were reared on caged plants individually to get samples for the studies on the changes in the morphology from the first instar nymph to the adult stage.

List of abbreviations used in the text

Al.	= Alate viviparous female
Ap. (p)	= Apterous viviparous female (Pigmented form)
Ap. (NP)	= Apterous viviparous female (Non-pigmented form)
h. t. 2	= Second segment of hind tarsus
L. ant.	= Length of antenna
L. base	= Length of base of last antennal segment
L. body	= Length of body
L. h. t. 2	= Length of second segment of hind tersus
L.h. tib.	= Length of hind tibia
L. p. t.	= Length of processus terminalis
L. siph	= Length of siphunculus
L. u.r.s.	= Length of ultimate rostral segment
p. t.	= Processus terminalis
u. r. s.	= Ultimate rostral segment
w. body	= Maximum width of body

Result

I. SEASONALITY AND PREPONDERANCE

Heavy infestation was recorded in the spring of 1983. Population declined with the rise in temperature in late

February and further dwindled in the first week of March. No aphid incidence was recorded throughout summer and rainy periods, i.e., from the second half of March to the second half of September until 28th September when few

TABLE 1. Seasonal preponderance of *Greenideoida ceyloniae* on *Mesua ferrea*

Month		Degree of Infestation	Morph composition	Infestation sites
1983				
February	6	Heavy	Al, Ap (P), Ap (NP)	Young leaves, Buds
	20	Moderate	Al, Ap (P)	Maturing leaves
March	4	Poor	Al	Senescing leaves
	25	None	None	None
April	10	,,	,,	
	25	,,		
May	9	,,		
	24	,,		
June	20	,,		
	25	,,		
July	9	,,		
	27	,,		
August	11			
	28			
September	10			
	28	Few	Al	New leaves
October	15	Moderate	Al	New leaves
	29	Heavy	Al, Ap (NP)	Young leaves
November	10	Heavy	Al, Ap (NP), Ap (P)	Young leaves, Mature leaves
	24	Heavy	,, ,, ,, ,, ,,	Young leaves, Mature leaves
December	10	Heavy	Al, Ap (P), Ap (NP)	Young leaves, Mature leaves
	25	Moderate	Al, Ap (P)	Mature leaves New sprouting
1984				
January	10	Poor	Al, Ap (P)	Mature leaves, New sproutings
	24	Poor	Al, Ap (P)	Mature leaves, New sproutings

Notations : Al=Alate viviparous female ; Ap (P)=Apterous viviparous female (Pigmented form) ; Ap (NP)=Apterous viviparous female (Non-pigmented form).

alatae were found feeding on new leaves. Population build-up started from the first half of October and heavy infestation prevailed till the first half of December thence slight decline in population was observed. Poor degree of infestation was recorded in January, the last observation date in this study (Table 1).

It is evident from the table 1 that *G. ceyloniae* occurred on its host for six months in a year and heavy infestation was recorded during three months. In rest of the period infestation was either moderate or poor and sometime even a few aphids only. Heavy infestation always comprised of alate viviparous females and apterous viviparous females of both pigmented and non-pigmented forms, while moderate and poor infestations comprised of alatae and pigmented form apterae only. From the table 1 it is also evident that immigrant alatae initiated colonizing new leaves of the host in late September and first generation aphid comprised of alatae only. These alatae gave birth to apterae of the non-pigmented form and soon infestation became heavy. With the maturation of leaves the pigmented form of apterae also appeared and made prolific infestation of new shoots and maturing leaves. Simultaneously, the non-pigmented form of apterae and alatae infested the young leaves. However, in the third month, the non-pigmented form of apterae disappeared leaving behind alatae and apterae (pigmented form). The non-pigmented form reappeared in February with the bearing of new and young leaves by the host but did not lasted long, although the pigmented form continued to thrive on the mature leaves and new shoots. With the onset of summer, the host was deserted by emigrant alatae.

II. MORPH SUCCESSION AND DISTRIBUTION ON THE HOST

The alate viviparous female occurred on all the infestation sites of the host and thrived throughout the period of its host association (Table 2). The first apterous generation produced is of the non-pigmented form which infested

preferably the young leaves. This is succeeded by the pigmented form of apterae which infested the new shoots,

TABLE 2. Morph succession and distribution on *Mesua ferrea*.

Morph	Site of infestation	Period of occurrence
Alate viviparous female	New leaves Young leaves Mature leaves Senescing leaves	Throughout
Apterous viviparous female (non-pigmented form)	Young leaves	February 1983 October 1984 November
Apterous viviparous female (pigmented form)	Mature leaves Buds New shoots New leaves	January 1983 February November 1984 December

new leaves and also the maturing leaves. The two forms of apterae seldom occurred together on the same leaf. Senescing leaves were colonized by alatae and its alatoid progeny only while new shoots were occupied by the pigmented form of apterae. So dense were the infestation that none of the new shoots survived after 5-6-leaf stage.

III. CHANGES IN THE ONTOGENY OF VIVIPAROUS MORPHS

i. APTEROUS VIVIPAROUS FEMALE

(Non-pigmented form)

Firat instar nymph

(Figs. 1A-6A)

Body 0.6-0.7 mm long and 0.25-0.3 mm in maximum width. Head smooth, without any frontal tubercles, fused with pronotum. Antennae 4-segmented, about 0.65 mm long as the body ; p. t. 2-2.5 × base of last antennal segment ; basal two segments smooth ; flagellum gradually distinctly imbricated toward apex apically ; flagellar hairs long with acute apices ; primary rhinaria circular, not ciliated and not protuberant. Rostrum elongated, with blunt apex ; segments 4 and 5 (u.r.s.) distinctly divided, 0.18-0.25 mm long

and about 2.35 × h.t. 2, bearing 4 secondary hairs. Legs pale brown, smooth ; femora stout ; tarsi imbricated ; first tarsal segments with 2 ventral hairs. Dorsum of abdomen smooth, membranous, with segmentally arranged long acute

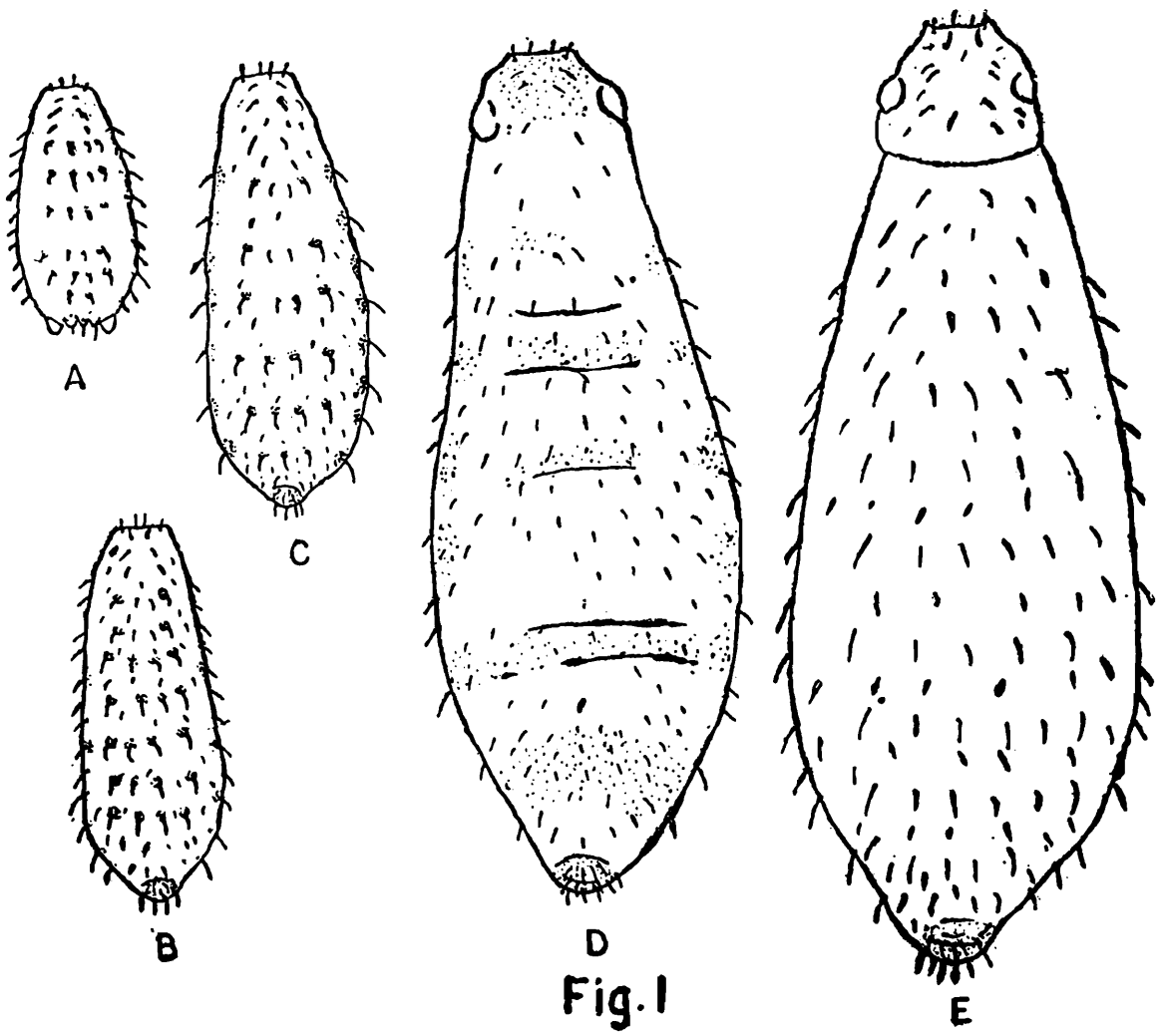


Fig. 1

Figs. 1A—1E : Apterous viviparous female (Non-pigmented form)—Body : 1A—first instar, 1B—second instar, 1C—third instar, 1D—fourth instar, 1E—Adult.

hairs placed on tuberculate bases ; each segment with 6 similar hairs—one pleural on each side, one marginal on each side and two dorsospinal ones. Siphunculi smooth, stumpy pale brown, without any hair, 0.06-0.15 mm long. Cauda semicircular.

Second instar nymph

(Figs. 1B-6B)

Body 1.07-1.2 mm long and 0.36-0.47 mm in maximum width. Antennae 4-segmented, about 1.05 mm long ; p. t. about 3 × base of last antennal segment. Ultimate rostral

segment 0.3-0.32 mm long and 3.4 × h. t. 2, bearing 6 secondary hairs ; segments 4 and 5 less distinctly seperated than in the first instar. Legs pale brown ; hind tibiae with

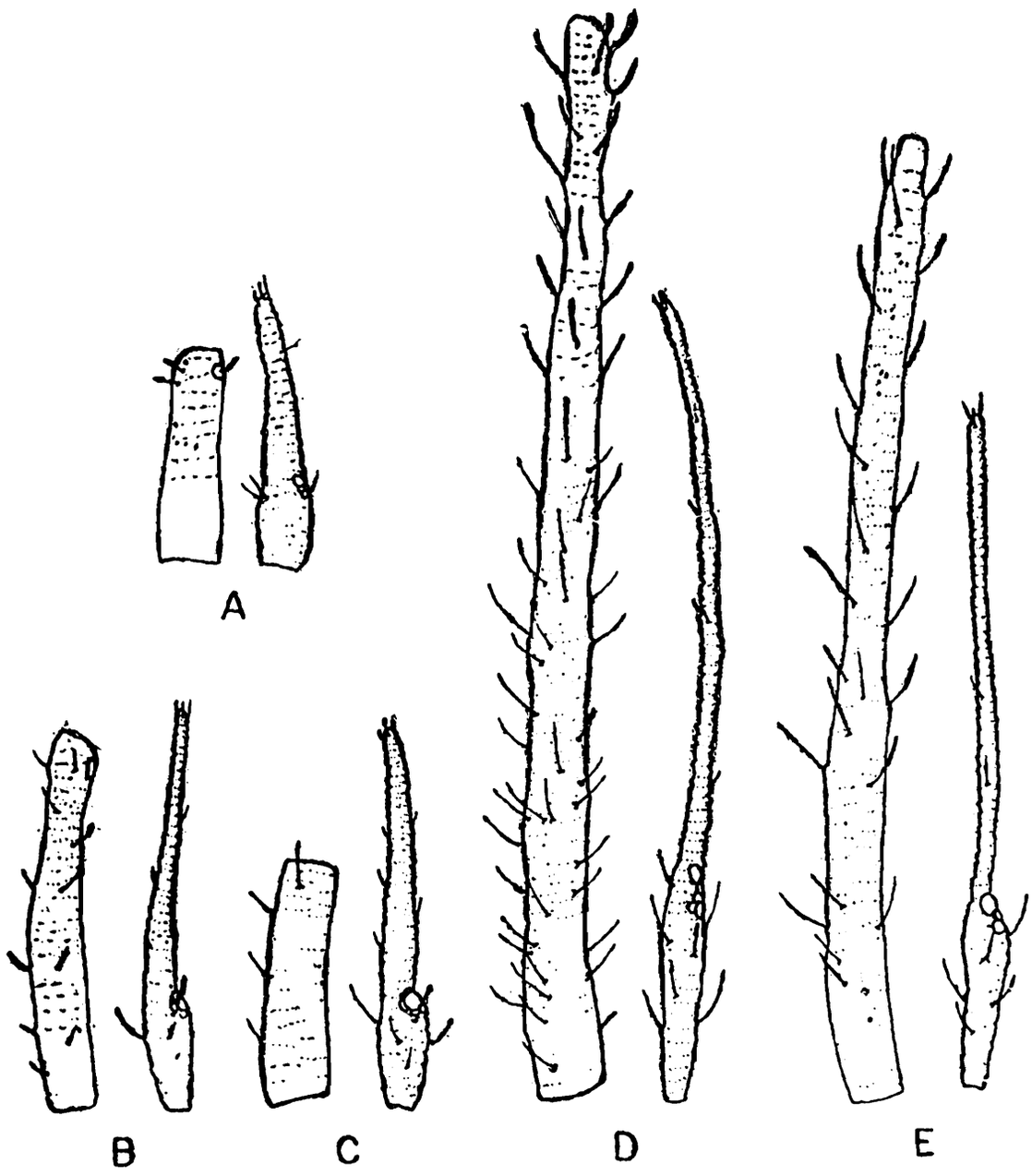


Fig. 2

Figs. 2A—2E : Apterous viviparous female (Non-pigmented form)—Antennal segment III and p.t. : 2A—first instar, 2B—second instar, 2C—third instar, 2D—fourth instar, 2E—Adult.

stridulatory ridges ; first tarsal segments with two long and one short ventral hairs. Dorsum of abdomen smooth and membranous. Siphunculi 0.37-0.42 mm long, about 2-8 × body and bearing hairs on distal half region. Cauda semicircular bearing several long hairs. Otherwise as in first instar nymph.

Third instar nymyh

(Figs. 1C-6C)

Body 1.3-1.8 mm long and 0.51-0.78 mm maximum width. Antennae 3-segmented, about 1.71 mm long ; p. t. 2.57 × base of last antennal segment. Eyes multifaceted with distinct triommatidia. Ultimate rostral segment 0.45-0.57 mm long, 4.48 × h. t. 2, bearing 8 secondary hairs ; segments 4 and 5

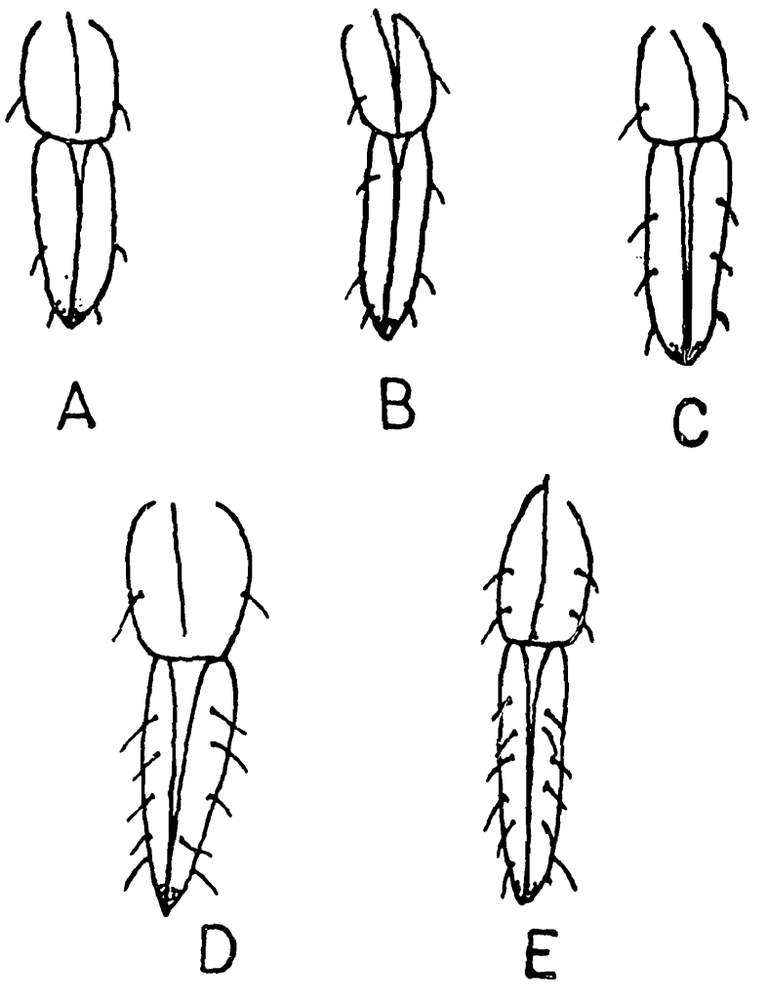


Fig. 3

Figs. 3A—3E : Apterous viviparous female (Non-pigmented form)—u. r. s. : 3A—first instar, 3B—second instar, 3C—third instar, 3D—fourth instar, 3E—Adult.

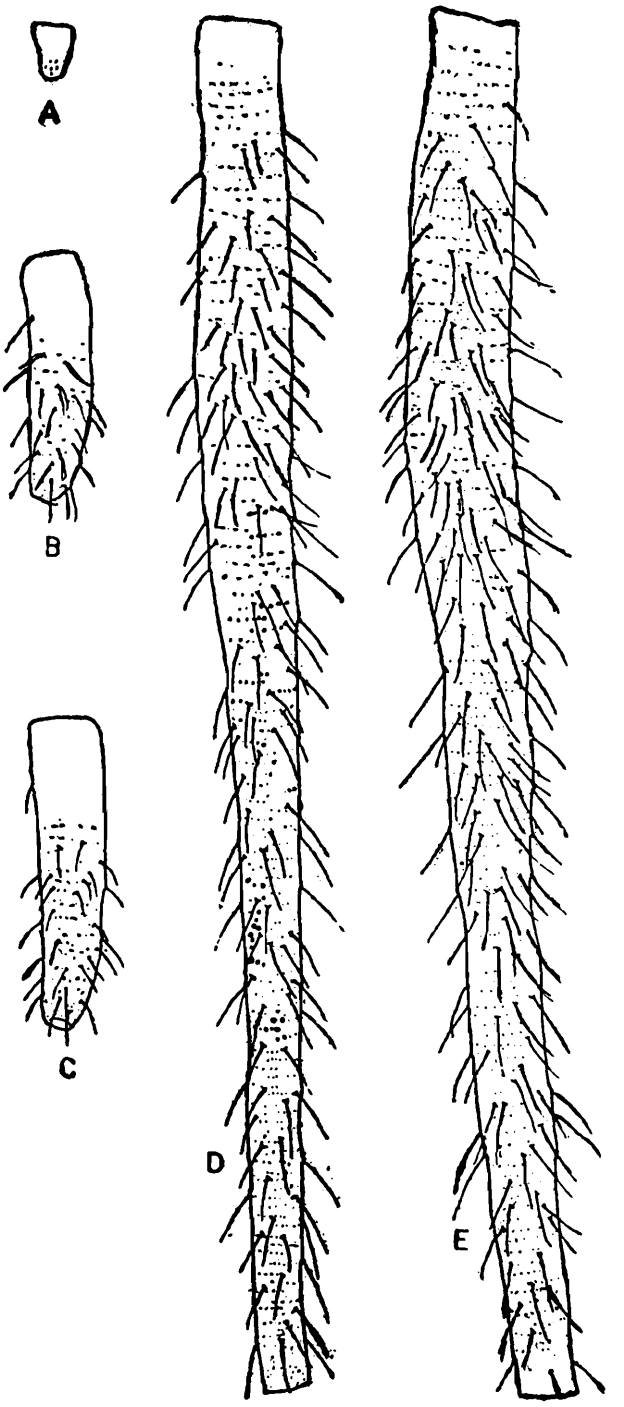
not distinctly seperated. Legs pale brown ; femora, tibiae and tarsi with spinules or spinular imbrications ; first tarsal segment with two long and two short hairs. Dorsum of abdomen smooth ; tuberculate bases of abdominal hairs less

prominent. Siphunculi 0.7-1.2 mm long, bearing longer hairs in distal half region and shorter hairs in proximal half region. Otherwise as in second instar nymph.

Fourth instar nymph

(Figs. 1D-6D)

Body 2.2-2.6 mm long and 0.8-1.1 mm in maximum width. Antennae 6-segmented, about 2.67 mm long; flagellum distinctly imbricated throughout; p. t. about 2.65



Figs. 4A—4E: Apterous viviparous female (Non-pigmented form)—Siphunculus: 4A—first instar, 4B—second instar, 4C—third instar, 4D—fourth instar, 4E—Adult.

× base of last antennal segment. Ultimate rostral segment 0.76-0.85 mm long, 6.96 × h. t. 2 and bearing 8 secondary hairs. Legs with spinular imbrications throughout; first tarsal segments with 5 ventral hairs. Dorsum of abdomen smooth, bearing upto 10 long and acute hairs on each

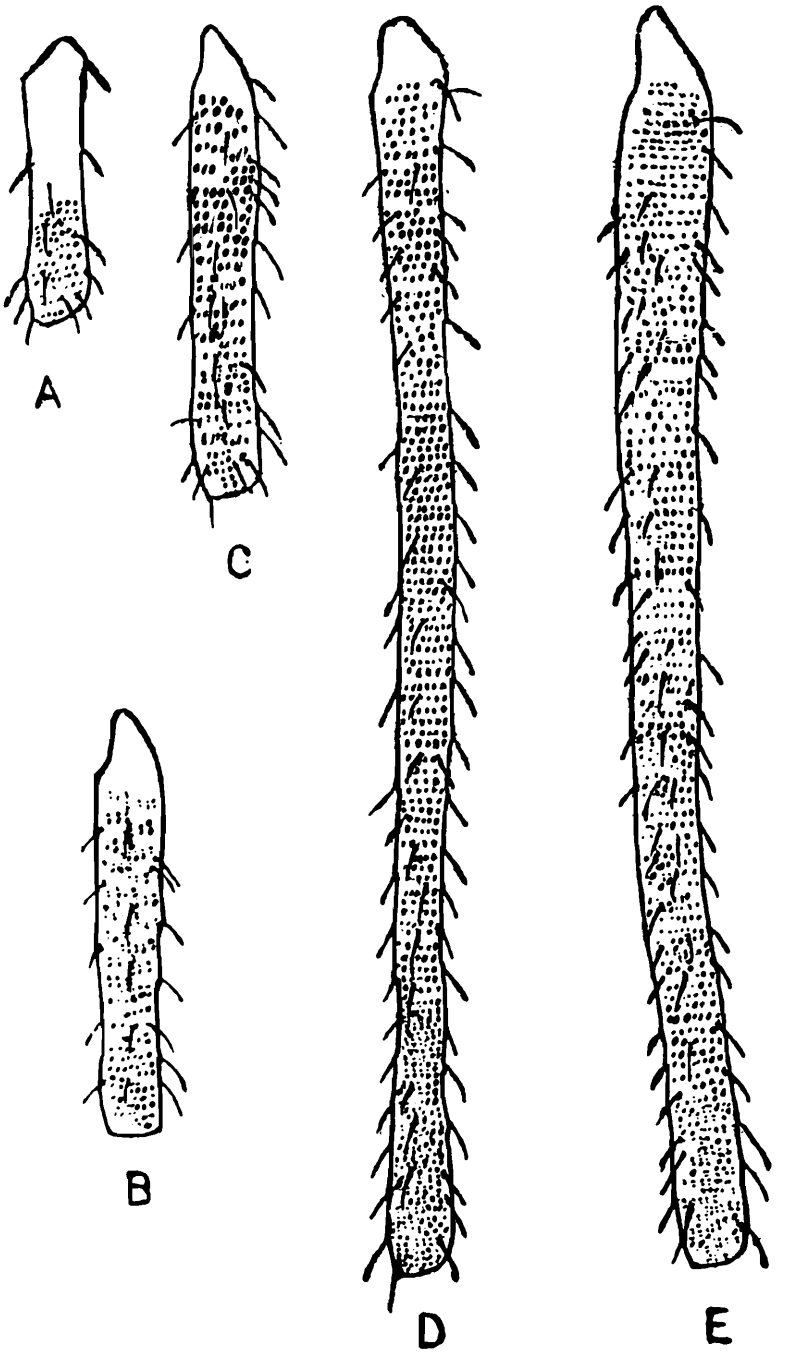


Fig. 5

Figs. 5A—5E: Apterous viviparous female (Non-pigmented form)—Hindtibia: 5A—first instar, 5B—second instar, 5C—third instar, 5D—fourth instar, 5E—Adult.

segment. Siphunculi 1.25-1.5 mm long, cylindrical, bearing hairs throughout except near the base. Otherwise as in third instar nymph.

Adult morph

(Figs. 1E-6E)

Body 2.5-3.12 mm long and 1.06-1.18 mm in maximum width. Antennae 6-segmented, 2.56-2.71 mm long ; p. t. 2.66-3.09 × base of last antennal segment. Ultimate rostral segment 0.9-0.98 mm long, 7.69 × h. t. 2, bearing upto 12

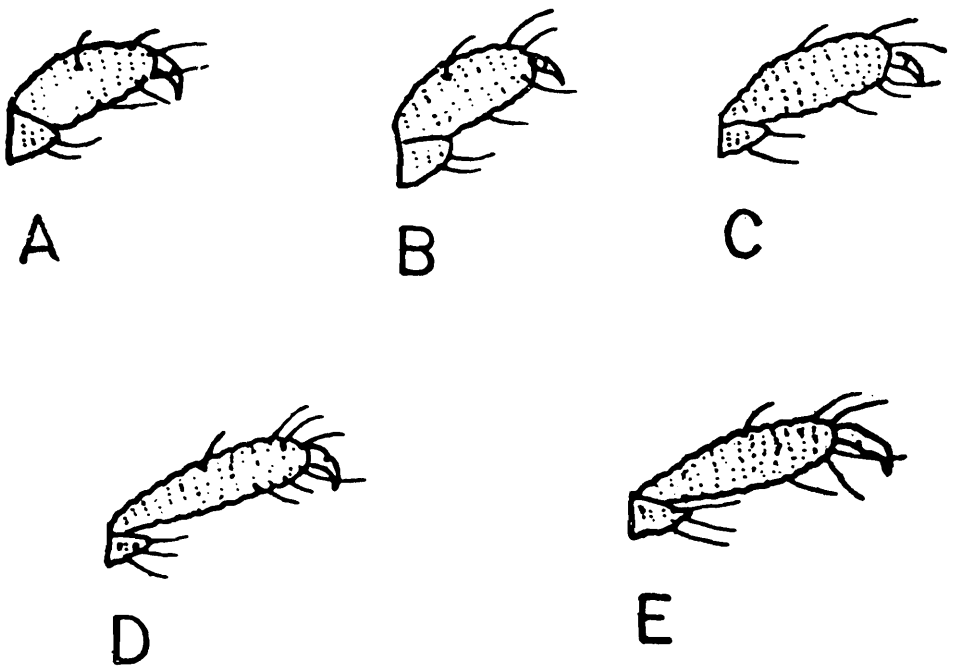


Fig. 6

Figs. 6A—6E : Apterous viviparous female (Non-pigmented form)—h. t. 2 : 6A—first instar, 6B—second instar, 6C—third instar, 6D—fourth instar, 6E—Adult.

secondary hairs. First tarsal segments with 5 ventral hairs. Dorsum of abdomen pale and smooth ; dorsal hairs without tuberculate bases ; hairs gradually becoming longer caudad. Siphunculi 1.87-2.23 mm long, narrow towards apex, outwardly curved and bearing hairs throughout except near the base. Otherwise as in fourth instar nymph.

II. APTEROUS VIVIPAROUS FEMALE (Pigmented form)

First instar nymph

(Figs. 7A-12A)

Body 0.76-0.83 mm long and 0.28-0.39 mm as maximum width. Antennae 4-segmented, about 0.26 mm long, p. t. 0.62 × base of last antennal segment. Ultimate rostral

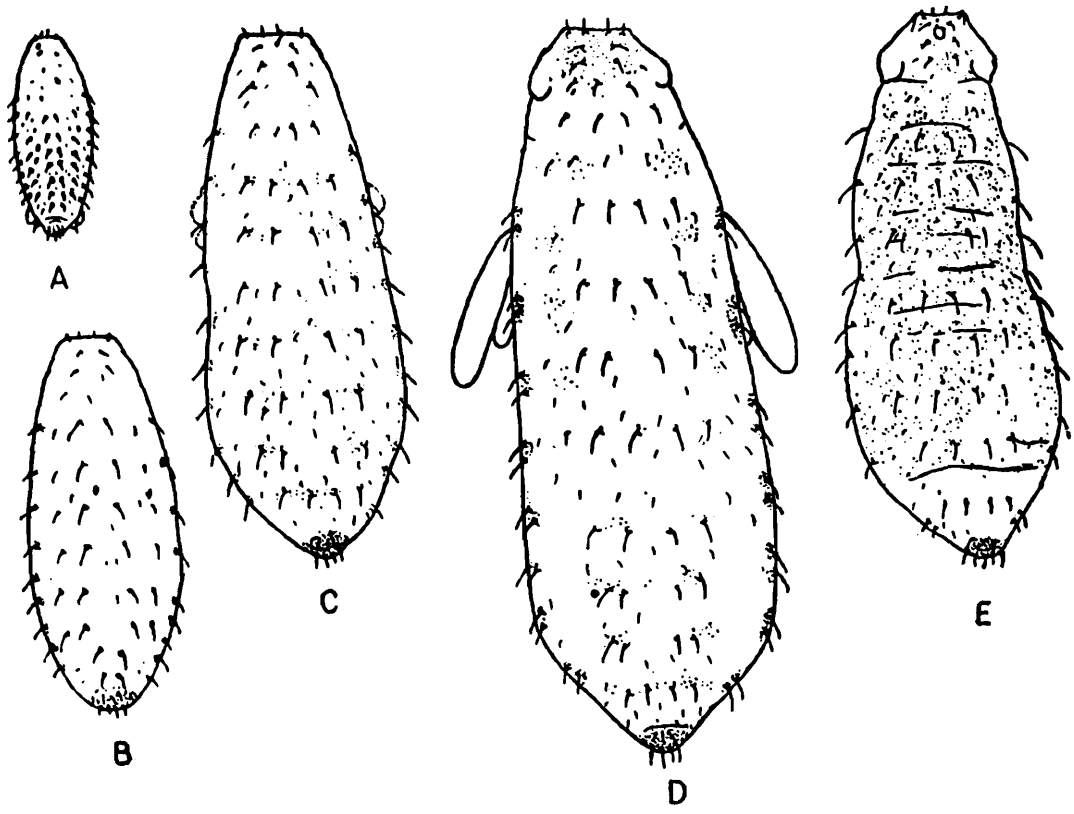


Fig. 7

Figs. 7A—7E : Apterous viviparous female (Pigmented form)—Body : 7A—first instar, 7B—second instar, 7C—third instar, 7D—fourth instar, 7E—Adult.

segment 0.23-0.25 mm long, 3 × h. t. 2, bearing 6 secondary hairs ; segments 4 and 5 not distinctly separated. Legs stout ; first tarsal segments with 2 ventral hairs. Dorsum of abdomen slightly pigmented, dorsal hairs long and acute, 6 on each ante-siphuncular segments, with tuberculate sclerotic bases, 4 such hairs on post-siphuncular segments with prominent bases. Siphunculi stumpy, 0.05-0.06 mm long and without any hair. Cauda semicircular. Otherwise similar to first instar nymph of non-pigmented form.

Second instar nymph

(Figs. 7B-12B)

Body 0.64-0.9 mm long and 0.3-0.4 mm as maximum width. Antennae 4-segmented, about 0.43 mm long ; p.t. 2.15 × base of last antennal segment. Eyes many-faceted.

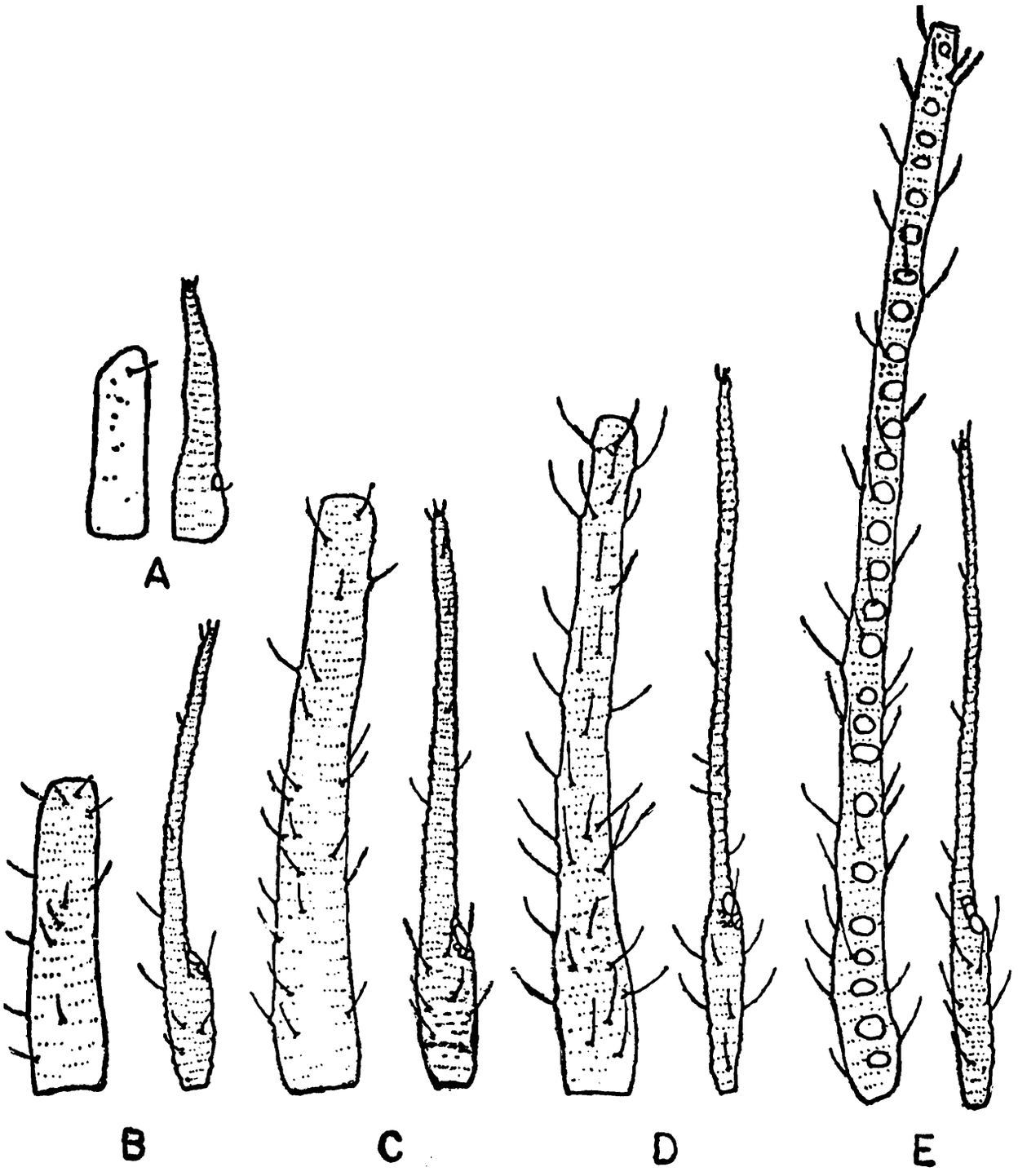


Fig. 8

Figs. 8A—8E : Apterous viviparous female (Pigmented form)—Antennal segment III and p.t. : 8A—first instar, 8B—second instar, 8C—third instar, 8D—fourth instar, 8E—Adult.

Ultimate rostral segment 0.28-0.33 mm long, 3 × h.t. 2, bearing 8 secondary hairs. Legs pale brown ; hindtibiae with few stridulatory ridges ; first tarsal segments with 3

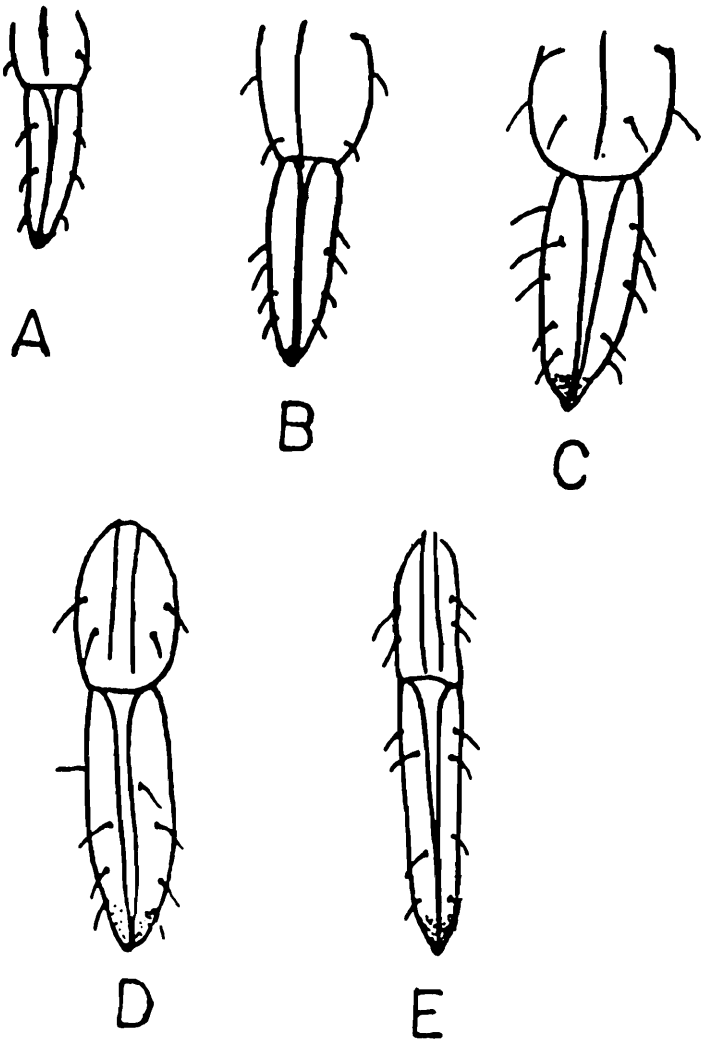


Fig 9

Figs. 9A—9E : Apterous viviparous female (Pigmented form)—u. r. s. : 9A—first instar, 9B—second instar, 9C—third instar, 9D—fourth instar, 9E—Adult.

ventral hairs. Siphunculi 0.6-0.8 mm long, broader at base and narrower at apex, bearing hairs on distal half region only. Otherwise similar to first instar and second instar nymphs of non-pigmented form.

Third instar nymph

(Figs. 7C-12C)

Body 1.48-1.92 mm long and 0.78-0.83 mm maximum

width. Antennae 5-segmented, about 1.08 mm long; p.t. 2.2 × base of last antennal segment. Ultimate rostral segment 0.47-0.8 mm long, 5.84 × h.t. 2, bearing 8 secondary hairs. Legs brown; hindtibiae with stridulatory ridges; first tarsal segments with 4 ventral hairs. Dorsum of abdomen smooth; dorsal hairs on non-tuberculate bases, upto 10 hairs on each of the ante-siphuncular segments, less

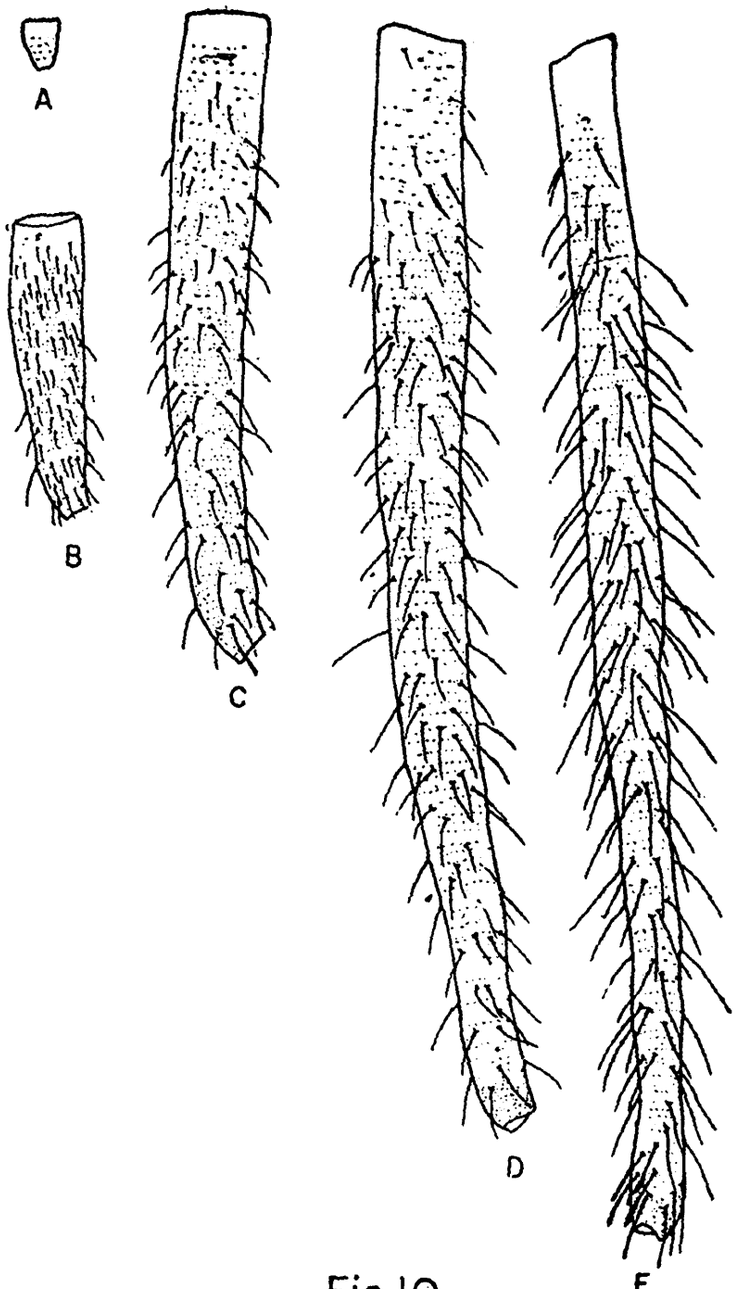


Fig.10

Figs. 10A—10E : Apterous viviparous female (Pigmented form)—siphunculus : 10A—first instar, 10B—second instar, 10C—third instar, 10D—fourth instar, 10E—Adult.

but more longer on post-siphuncular segments. Siphunculi 0.62-0.82 mm long, bearing hairs throughout except near the base. Otherwise similar to second instar and third instar nymphs of non-pigmented form.

Fourth instar nymph

(Figs. 7D-12D)

Body 1.72-2.1 mm long and 0.78-0.98 mm as maximum width. Antennae 6-segmented, about 1.37 mm long;

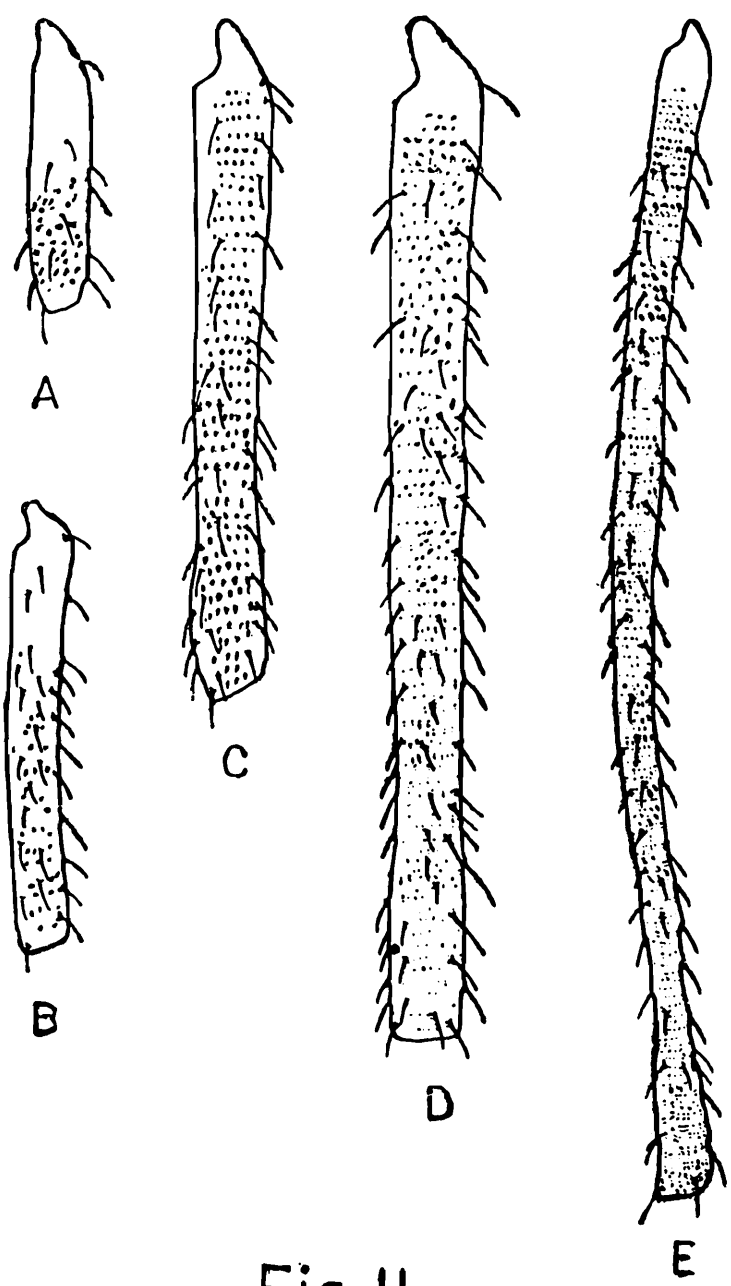


Fig. 11

Figs. 11A—11E: Apterous viviparous female (Pigmented form)—Hind—tibia: 11A—first instar, 11B—second instar, 11C—third instar, 11D—fourth instar, 11E—Adult.

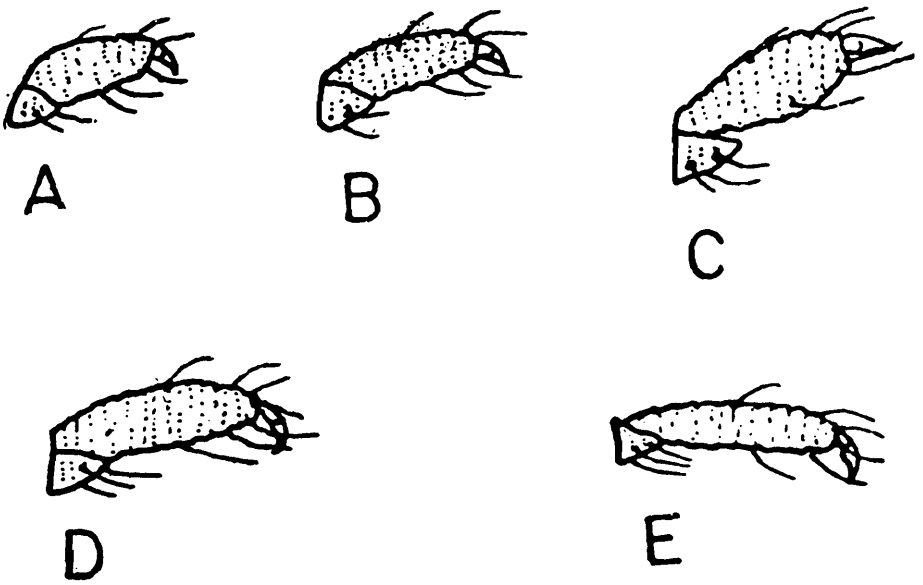


Fig.12

Figs. 12A—12E: Apterous viviparous female (Pigmented form)—h. t. 2 : 12A—first instar, 12B—second instar, 12C—third instar, 12D—fourth instar, 12E—Adult.

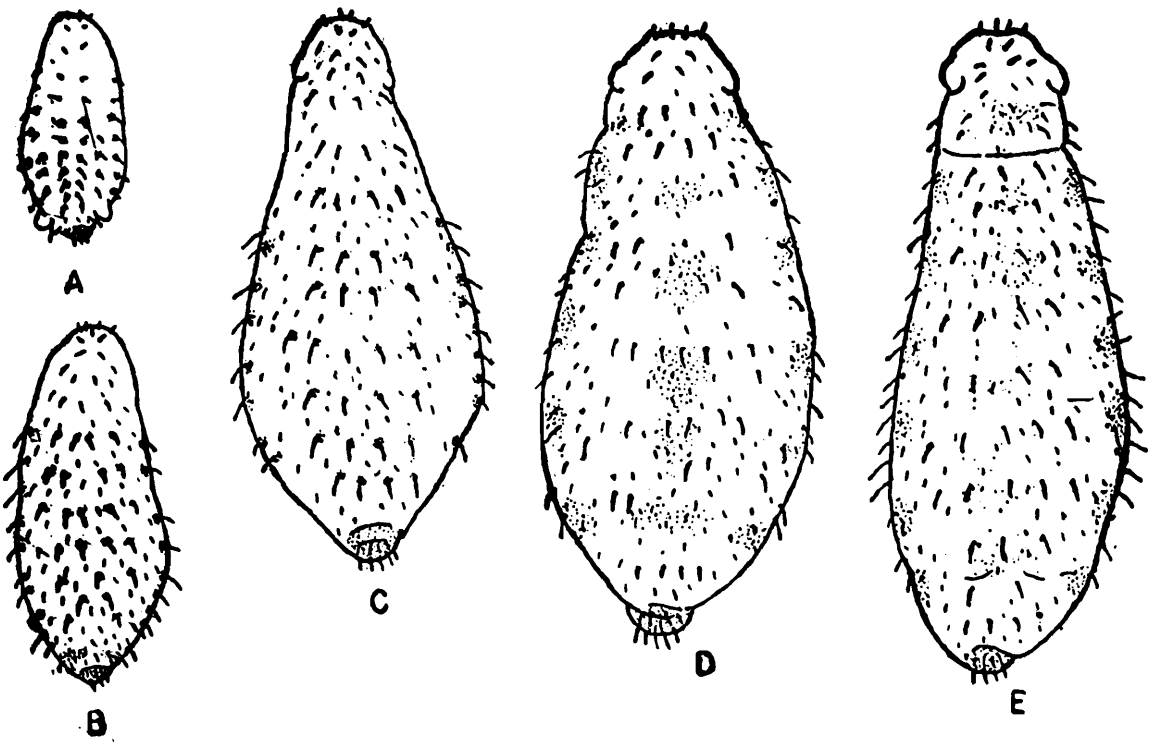


Fig.13

Figs. 13A—13E : Alate viviparous female—Body : 13A—First instar, 13B—second instar, 13C—third instar, 13D—fourth instar, 13E—Adult (wing ommitted).

flagellum imbricated throughout ; p.t. 1.84 × base of last antennal segment. Ultimate rostral segment 0.76-0.84 mm long, 5.86 × h.t. 2, bearing 8 secondary hairs. Legs brown, first tarsal segments with 5 ventral hairs. Dorsum of abdomen pigmented, rugose and spinulose ; dorsal hairs

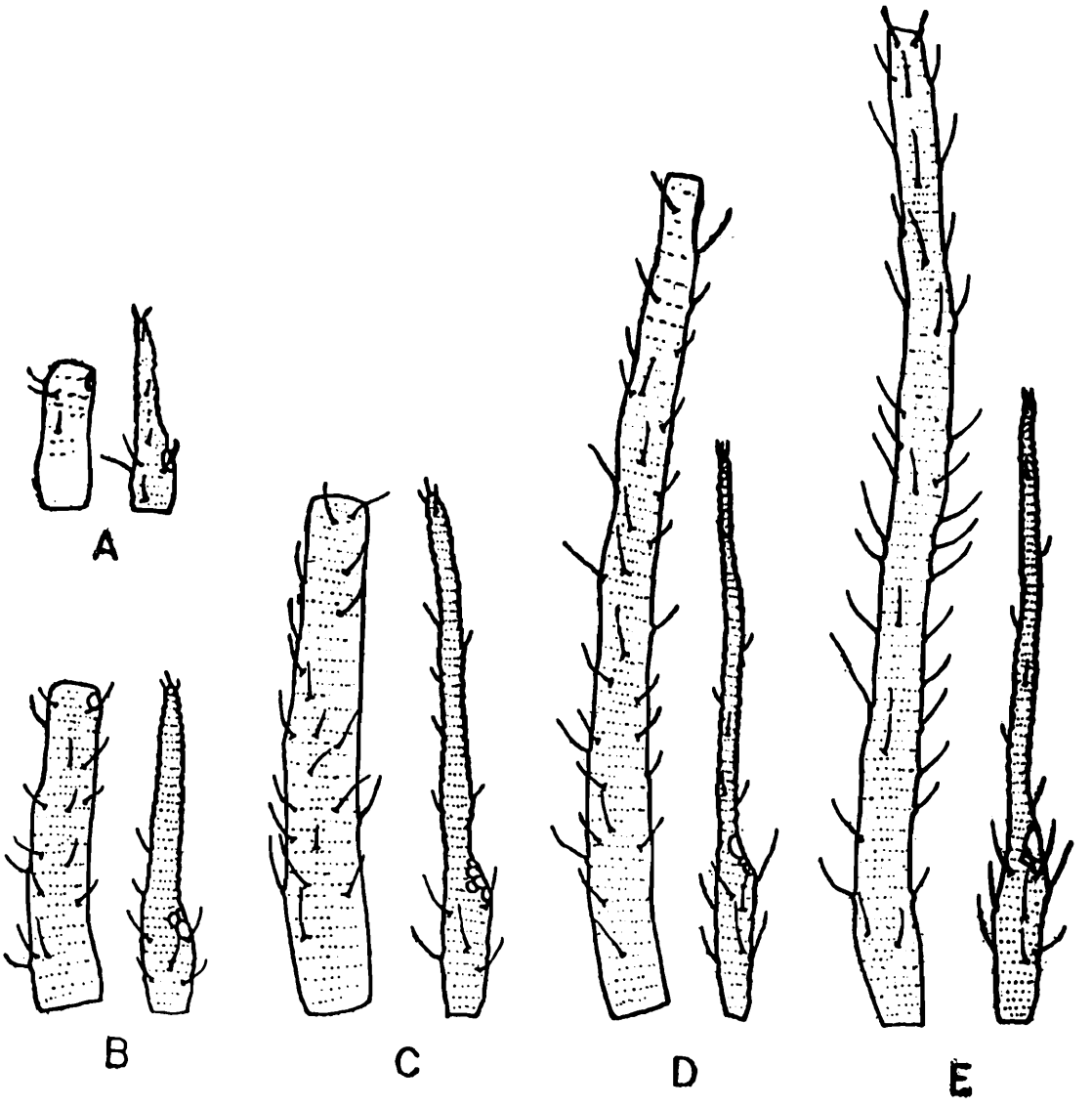


Fig. 14

Figs. 14A—14E : Alate viviparous female—Antennal segment III and p. t. : 14A—first instar, 14B—second instar, 14C—third instar, 14D—fourth instar, 14E—Adult.

stout and acute. Siphunculi 0.65-1.25 mm long, broader towards basal half and somewhat narrow towards apices, spinulose, bearing hairs throughout except near the base, without any reticulation. Cauda semicircular, bearing many long hairs. Otherwise as in third instar and fourth instar nymphs of non-pigmented form.

Adult viviparous female

(Figs. 7E-12E)

Body 1.51-2.18 mm long and 0.62-1.9 mm maximum width. Antennae 6-segmented, 1.15-1.59 mm long ; p. t. 1.8-2.0 × base of last antennal segment. Ultimate rostral segment 0.78-0.81 mm long, 6.85 × h.t. 2 and bearing 8 secondary hairs ; segments 4 and 5 not distinctly seperated. Legs brown, spinulose ; first tarsal segments with 5 ventral

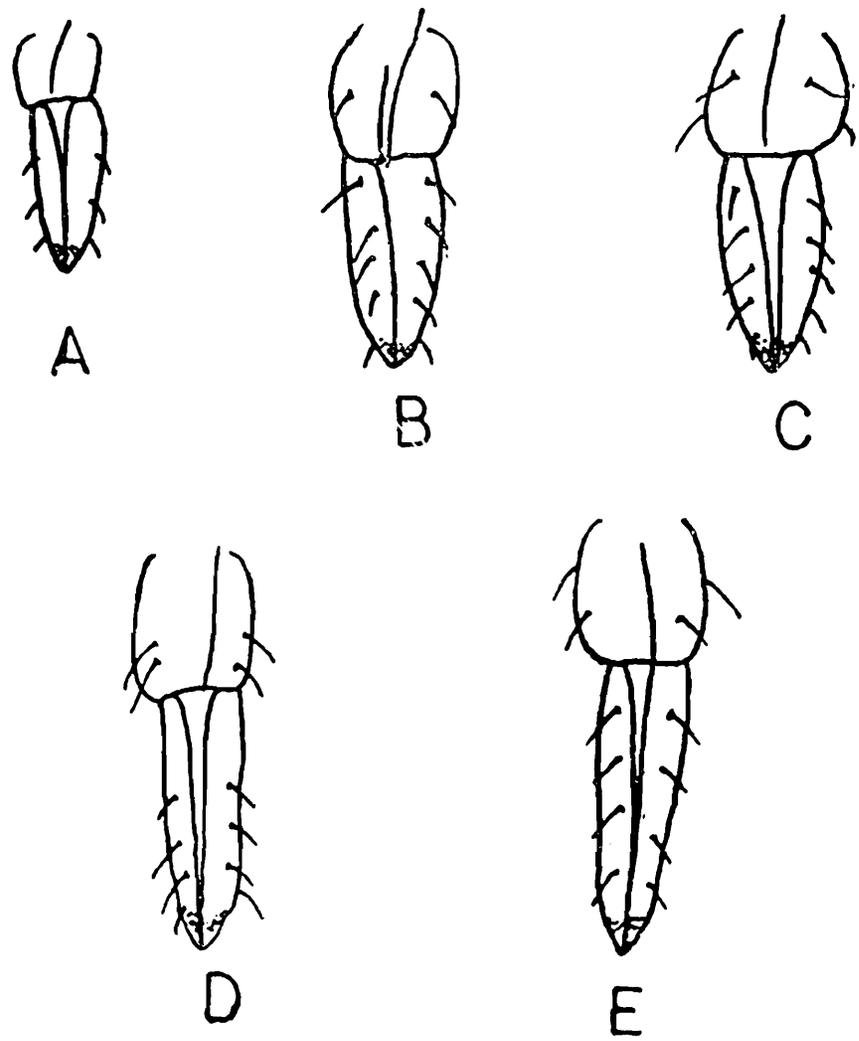


Fig. 15

Figs. 15A—15E : Alate viviparous female—u.r.s. : 15A—first instar 15B—second instar, 15C—third instar, 15D—fourth instar, 15E—Adult.

hairs. Dorsum of abdomen pigmented except in the dorso-median region which is pale ; sclerotic and rugose patches on the two sides along pale region of ante-siphuncular segments ; post-siphuncular segments pale. Siphunculi deep brown or black, curved outward, 0.65-0.98 mm long, bearing

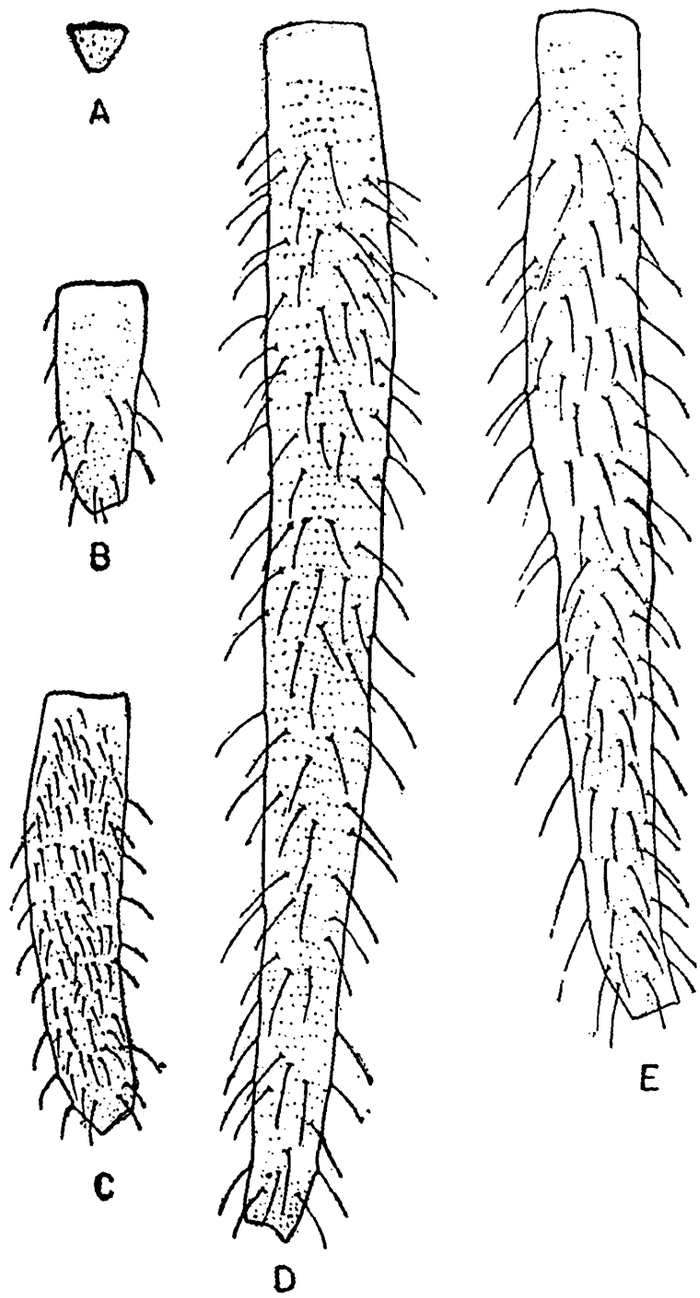


Fig.16

Figs. 16A—16E ; Alate viviparous female—siphunculus : 16A—first instar, 16B—second instar, 16C—third instar, 16D—fourth instar, 16E—Adult.

hairs throughout except near the base ; spinulose throughout. Cauda pale. Otherwise similar to fourth instar nymph.

III. ALATE VIVIPAROUS FEMALE

First instar nymph

(Figs. 13A-18A)

Body 0.75-1.09 mm long and 0.3-0.6 mm as maximum width. Head smooth. Antennae 4-segmented, about 0.7 mm long ; flagellum with spinular imbrications ; p.t. 2.1 × base of last antennal segment ; without any secondary

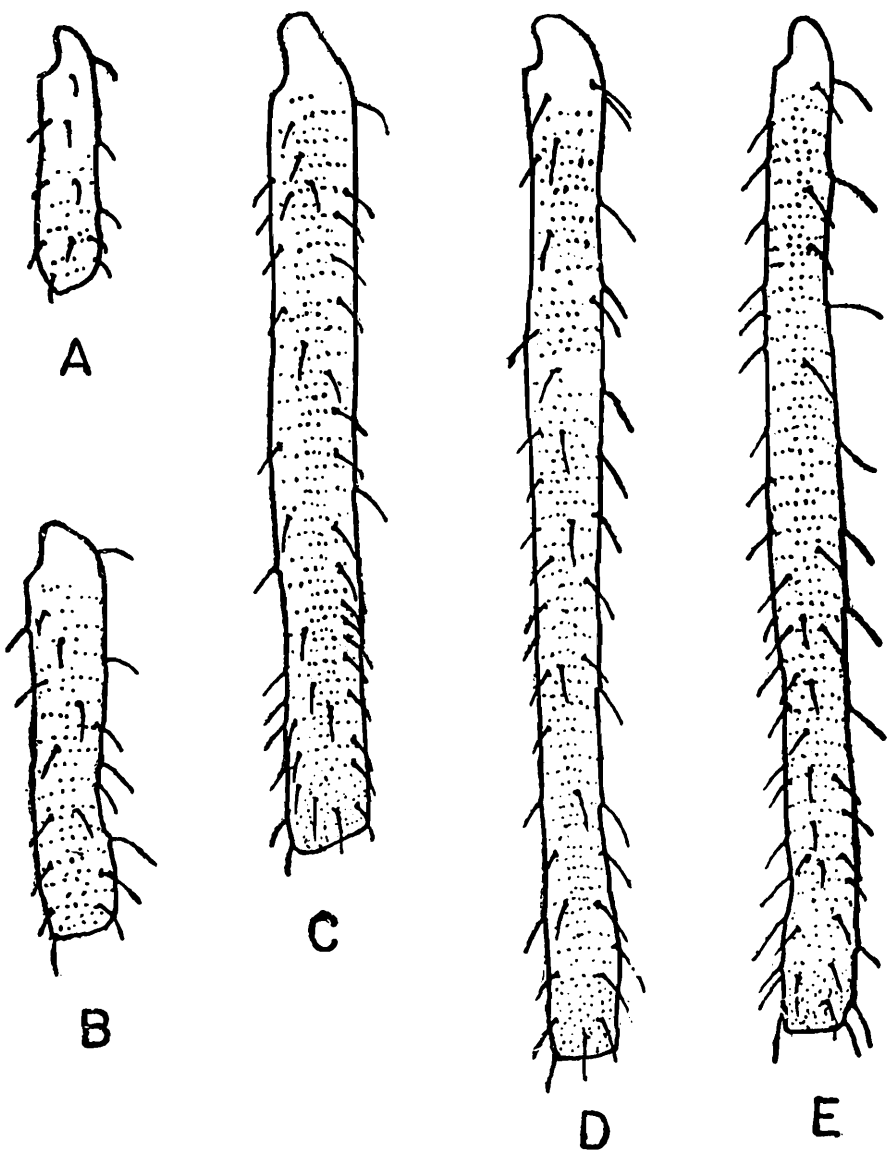


Fig.17

Figs. 17A—17E : Alate viviparous female—Hindtibia : 17A—first instar, 17B—second instar, 17C—third instar, 17D—fourth instar, 17E—Adult.

rhinaria ; primary rhinaria rounded, non-ciliated. Rostrum blunt ; ultimate rostral segment 0.3-0.4 mm long, 3.9 × h.t. 2, bearing 6 secondary hairs. Dorsum of abdomen smooth, dorsal hairs long, acute, placed on tuberculate bases, 6 hairs on each segment, hairs gradually longer caudad. Siphunculi stumpy, 0.16-0.3 mm long, without any hair. Cauda transversely semioval. Legs pale brown, smooth. First tarsal segments with two ventral hairs. Otherwise similar to first instar nymph of apterae.

Second instar nymph

(Figs. 13B-18B)

Body 1.2-1.6 mm long and 0.5-0.64 mm as maximum width. Antennae 4-segmented, 3rd segment incompletely divided, about 0.9 mm long ; p.t. 2.26 × base of last antennal

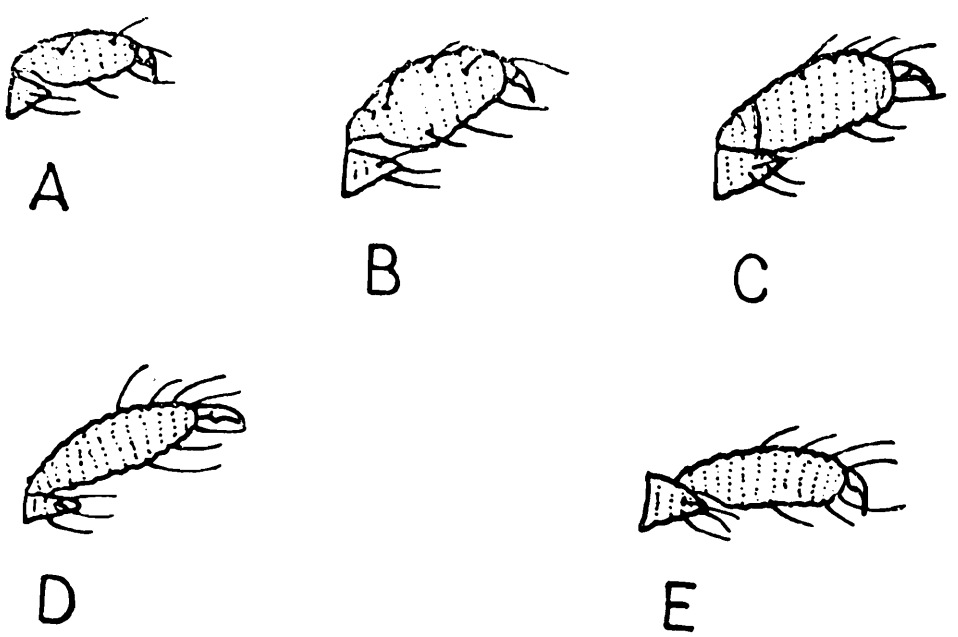


Fig 18

Figs. 18A—18E : Alate viviparous female—h. t. 2 : 18A—first instar, 18B—second instar, 18C—third instar, 18D—fourth instar, 18E—Adult.

segment ; flagellum slightly imbricated, bearing long and acute hairs ; without any secondary rhinaria. Ultimate rostral segment 0.35-0.46 mm long, 4.0 × h.t. 2 and with 10

secondary hairs. Dorsum of abdomen pale brown, nearly smooth. Siphunculi cylindrical, 0.19-0.25 mm long, bearing hairs throughout. Legs pale brown ; femora, tibiae and tarsi with spinules ; hind tibiae with stridulatory ridges ; first tarsal segments with 3 ventral hairs. Otherwise similar to second instar nymph of apterae.

Third instar nymph

(Figs. 13C-18C)

Body 1.4-1.9 mm long and 0.55-0.86 mm as maximum width. Antennae 5-segmented, about 1.6 mm long, p.t. 2.7 × base of last antennae segment. Wing buds on meso- and metathoracic segments distinguishable. Ultimate rostral segment 0.5-0.6 mm long, 1.81 × h.t. 2 and bearing 6 secondary hairs. Dorsum of abdomen pale brown, nearly smooth ; dorsal hairs upto 10 on each of the ante-siphuncular segments. Siphunculi pale, 0.1-0.14 mm long, broader basally and narrow apically, bearing hairs throughout except near the base. Cauda semioval. Legs pale brown ; first tarsal segments with hairs. Otherwise similar to third instar nymph of apterae.

Fourth instar nymph

(Figs. 13D-18D)

Body 2.34-3.04 mm long and 0.7-0.8 mm as maximum width. Antennae 6-segmented, about 1.92 mm long ; without any secondary hairs, wing-buds prominent, without venation. Ultimate rostral segment 0.8-0.9 mm long, 6.7 × h.t. 2 and bearing 8 secondary hairs. Dorsum of abdomen nearly smooth, dorsal hairs without any tuberculate base. Siphunculi 0.26-0.33 mm long, pale brown, outwardly directed, bearing hairs throughout but less so near the base and apex. Cauda roundly semioval. Otherwise similar to fourth instar nymph of apterae.

Adult viviparous female

(Figs. 13E-18E)

Description similar to as provided by Raychaudhuri (1956) and Agarwala (1982).

IV. ANALYSIS OF VARIATIONS : (tables 3, 4 & 5) :

Both quantitative and qualitative variations are evident in the ontogenic stages of each morph. Absolute measurements of various characters like the length of the body, antennae and siphunculi exhibit large differences between different instars of each morph. Certain characters like length of u. r. s. and h. t. 2 are less variable and except for minute distinguishable variations in succeeding instars, overlapping variations are more often seen. Number of dorsal hairs on the abdomen changes appreciably from the first instar to the adult stage and along with it also changes their quality. In the first two instars of each morph dorsal abdo-

TABLE 3. Measurements (average of 10 specimens) of some morphological characters in apterous viviparous female (non-pigmented form) of *G. ceyloniae*.

Characters	*First instar*		*Second instar*		*Third instar*		*Fourth instar*		*Adult*	
	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
L. Body	0.6	0.7	1.07	1.2	1.3	1.8	2.2	2.57	2.5	3.12
W. Body	0.25	0.36	0.35	0.47	0.5	0.8	0.86	1.1	1.06	1.2
L. ant.	0.46	0.7	0.82	1.05	1.1	1.2	1.0	1.7	1.4	1.6
L. base	0.062	0.093	0.09	0.2	0.14	0.17	0.14	0.17	0.78	0.16
L.p.t.	0.16	0.19	0.28	0.37	0.31	0.46	0.16	0.37	0.17	0.37
L.u.r.s.	.018	.025	.028	.03	.045	.058	.076	.085	.093	.097
L.h.t.2	0.08	0.11	0.08	0.09	0.11	0.12	0.1	0.12	0.1	0.14
L. siph.	0.06	0.1	0.37	0.4	0.7	1.2	1.3	1.5	1.9	2.2
L.h.tib.	0.16	0.2	0.2	0.37	0.37	0.55	0.5	0.6	0.7	0.8

TABLE 4. Measurements (average of 10 specimens) of some morphological characters in apterous viviparous female (pigmented form) of *G. ceyloniae*.

Characters	First instar		Second instar		Third instar		Fourth instar		Adult	
	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
L. Body	0.76	0.83	0.64	0.9	1.5	1.9	1.7	2.1	1.5	2.2
W. body	0.3	0.4	0.3	0.4	0.8	0.83	0.8	0.98	0.6	1.0
L. ant.	0.24	0.27	0.35	0.45	1.18	1.37	2.01	2.61	2.15	2.76
L. base	0.06	0.062	0.046	0.062	0.14	0.156	0.17	0.2	0.19	0.2
L. p. t.	0.03	0.046	0.12	0.14	0.23	0.4	0.42	0.5	0.45	0.59
L. u. r. s.	0.023	0.025	0.028	0.033	0.047	0.08	0.076	0.084	0.078	0.081
L. h. t. 2	0.05	0.06	0.09	0.11	0.09	0.12	0.09	0.12	0.09	0.14
L. siph.	0.04	0.06	0.06	0.08	0.6	0.8	0.65	1.2	0.6	0.98
L. h. tib.	0.16	0.17	0.2	0.26	0.34	0.47	0.47	0.59	0.47	0.6

TABLE 5. Measurements (average of 10 specimens) of some morphological characters in alate viviparous female of *G. ceyloniae*.

Characters	First instar		Second instar		Third instar		Fourth instar		Adult	
	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
L. body	0.75	1.09	1.2	1.6	1.4	1.8	2.3	3.04	2.5	2.7
W. body	0.3	0.6	0.5	0.64	0.55	0.8	0.8	1.07	0.8	0.97
L. ant.	0.3	1.0	0.8	1.1	1.3	1.5	1.7	1.9	2.0	2.6
L. base	0.03	0.1	0.1	0.14	0.1	0.16	0.16	0.25	0.18	0.2
L. p. t.	0.03	0.2	0.25	0.3	0.34	0.4	0.4	0.5	0.43	0.56
L. u. r. s.	0.034	0.04	0.034	0.046	0.047	0.057	0.078	0.09	0.078	0.086
L. h. t. 2	0.06	0.13	0.09	0.1	0.1	0.12	0.1	0.14	0.1	0.14
L. ship	0.06	0.12	0.4	0.44	0.8	0.9	1.35	1.9	1.6	2.3
L. h. tib.	0.16	0.4	0.3	0.33	0.34	0.46	0.6	1.03	0.62	0.8

minal hairs are six in number on each segment and with tuberculate bases, but these bases become non-tuberculate from the third instar and their number increases upto ten per segment in the fourth instar and adult. Number of secondary hairs on u.r.s., although varies among ontogenic stages, often overlap between the two suceeding instars. Siphunculi and antennae change their characters more appreciably than other structures. Non-hairy, smooth and stumpy siphunculi of the first instar becomes hairy and cylindrical in the second instar, spinulose or imbricated and apically narrowed in the third instar and outwardly directed in the fourth instar and the adult. Number of antennal segments is always four in the first and second instars, five in the third instar and six in the fourth instar and the adult. Antennal segment III and p.t. increase in length more appreciably than the rest of the segments and remain distinct in length in each of the nymphal instars and adult.

Inter-morph variations in each instar are also notable. In apterae viviparae, the non-pigmented form can be easily separated from the pigmented form at any stage of development in the longer body, longer antennae and longer siphunculi. Besides, in life, the progeny of the two forms are easily distinguishable in the absence of the dark pigment of the body and pale siphuculi on the non-pigment form. Most of the qualitative characters are rather constant among morphs except for the presence of spinule and rugosity in the third and

fourth instars and adult of the pigmented form and its nearly total absence in the non-pigmented form. In alatae viviparae the wing-bud is not discernable until second instar and secondary rhinaria on the antenna appear only in the adult.

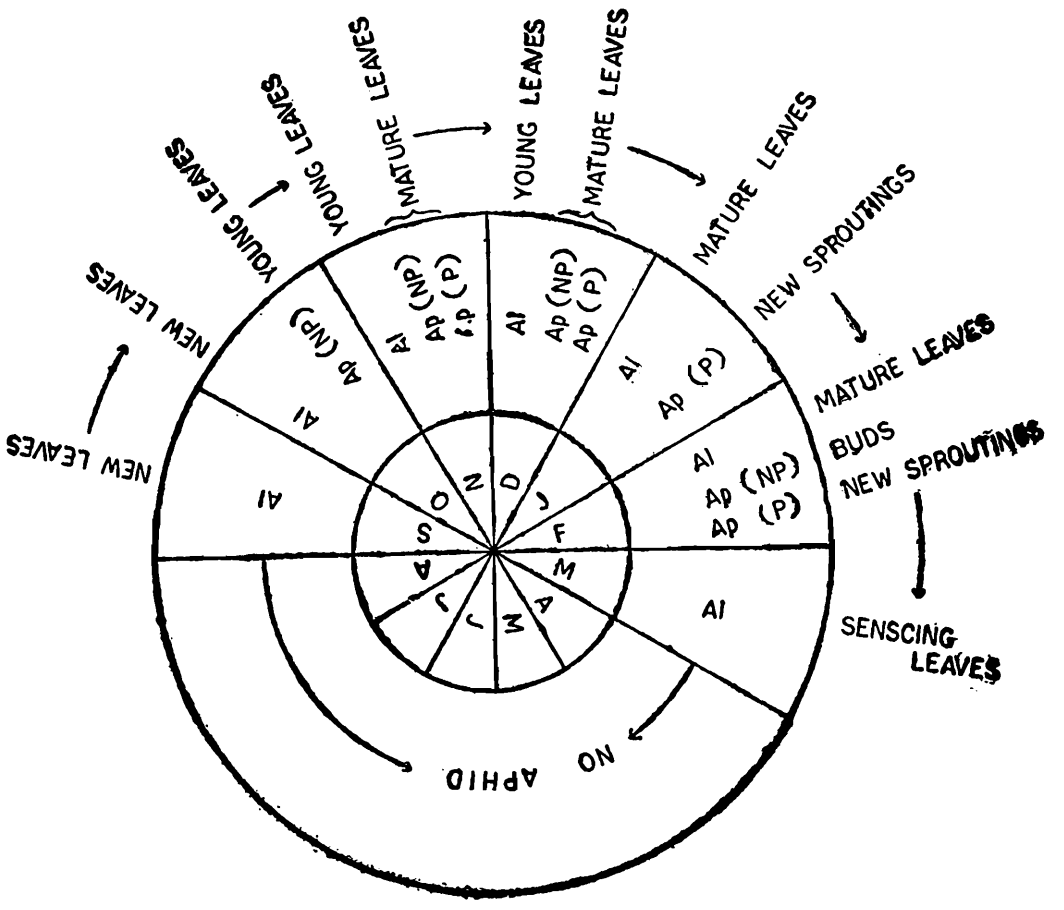


Fig. 19 : Life table

Notably the stridulatory ridges, which is one of the characteristics of the subgenus *Paragreenideoida* to which *ceyloniae* belongs, are more or less distinct in the second instar and becomes more prominent in later stages.

Discussion

Aphids, being polymorphic insects, are easily suspectible to non-genetic variations caused by the host-condition, climatic changes and crowding effect because of parthenogenetic viviparity. Very often it is hard to distinguish the developing stages of two closely related species and even within a species between different morphs. In *G. ceyloniae*

where polymorphism occurs almost throughout the period of aphid incidence on its specific host, it is necessary to know the morphology of different morphs in their developing and adult stages and the variations between them.

In the present investigation alate morph maintains its population on the host from the inception in September till the end of March of the following year. The first apterous generation of the non-pigmented form appear towards the end of October. This morph prefers feeding on young leaves and in the following months spread to new leaves and new shoots where the pigmented form of apterae are produced. The non-pigmented form disappears with the maturation of leaves and the pigmented form occupies its place. Until the onset of spring in February of the following year this situation persists when the host start bearing young leaves, and this sets the production of the non-pigmented form again. For about one month all the three morphs occur on the same host but the non-pigmented form is short-lived and disappears with the maturation of leaves. The distinct habitat of the two forms of apterae viviparae seems to be the result of high degree of polymorphism and is a positive factor in the exploitation of host. Further, the availability of alate viviparae throughout the duration of aphid incidence is indicative of monitoring the capacity of reproduction in this species which can be linked with the seasonality of the host plant. (Fig. 19) Morphological changes in the ontogeny of different morphs are important parameter in measuring the variation which is vital in the correct understanding of taxonomy and biology of aphids. Also, very often only immature specimens are available in the collection. Knowledge of characters of developing stages makes it possible to identify them. However, such knowledge shall be incomplete until more studied on the related species are accumulated. This seems to be more relevant in the case of aphids which are highly polymorphic. Unfortunately, such a study is wanting for majority of aphid species known till today (Eastop and Hills Ris Lambers, 1976). Present investigation has made

it possible to identify the *G. ceyloniae* by its various viviparous female morphs and their immature stages.

Summary

This paper presents morphological changes in the ontogeny of apterous and alate viviparous female morphs of *Greenideoida ceyloniae* v. d. Goot, seasonal variations in the morphology of adult forms, seasonal preponderance and morph succession and distribution on *Mesua ferrea* for the first time from Oriental Region.

Acknowledgements

Sincere thanks are attributed to Dr. Bithi Sircar, In-charge, Deptt. of Life Science of this institution (BKA & MKP) and Dr. B. K. Tikader, Director, Zoological Survey of India (AKG) for extending laboratory facilities and to Dr. V. F. Eastop, British Museum, London for his helpful comments in course of this study.

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