

MOTH EAR MITES : NEW FINDINGS
AND A NEW SPECIES FROM NORTH AMERICA

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ABSTRACT

A mite believed to be *Dicrocheles scedastes*, previously known from the Old World only, was collected in Massachusetts from 13 feral noctuids of various species, and reared on 23 noctuids that were experimentally infaunated. In two instances the mites were synhospitalic with *D. phalaenodectes*. Both ears of the hosts were invaded, and the path of approach to the ears appeared to be subalar rather than dorsal as in *phalaenodectes*. The countertympanic septum was usually perforated, but the tympanic membranes and acoustic sensilla often escaped destruction, so that the moths retained acoustic sensitivity. Earlier records of *Dicrocheles* are in part revised, and a new species, *D. hippeoides*, is described from a unilateral colony in a plusiine noctuid from Louisiana.

RÉSUMÉ

Une espèce d'acarien, présumée être *Dicrocheles scedastes*, inconnue jusqu'ici en Amérique, a été découverte dans l'état du Massachusetts, chez 13 noctuides sauvages de divers espèces. Cet acarien a été élevé sur 23 noctuides expérimentalement infestés. Dans deux cas les acariens étaient associés avec *D. phalaenodectes*. Les deux organes tympaniques de l'hôte étaient envahis, et le chemin d'approche semblait être subalaire au lieu de dorsal comme chez *phalaenodectes*. La cloison contretympanique était d'habitude perforée, mais les membranes tympaniques et les sensilles acoustiques échappaient souvent à la destruction, permettant aux hôtes de retenir la sensibilité acoustique. Les descriptions précédentes sont en partie révisées, et une nouvelle espèce est décrite, provenant d'une colonie unilatérale chez une noctuide plusiine de la Louisiane, U.S.A.

Until 1975, the only species of the mesostigmatid genus *Dicrocheles* that had been recognized or reported from the New World was *phalaenodectes* (Treat). In 1970, I gave records of this species from North, South, and Central America, the Antilles and Hawaii, and described three additional species, including *scedastes*, from various but exclusively Old World sources, correcting my previous mistaken determinations of these as *phalaenodectes*. These records were summarized in my book *Mites of Moths and Butterflies* (1975). In the late summer of 1975, when the book had already gone to press, moths began to appear at my collecting light in Tyringham, Massachusetts, with both ears heavily colonized by mites that I at first supposed were *Dicrocheles phalaenodectes*. Since this species normally invades only one ear of its host (I have seen only ten exceptions in feral hosts during twenty-three years of collecting), it was clearly necessary to investigate.

While at low magnification the physical appearance of the living mites was not noticeably different from that of *phalaenodectes*, at least in the young females and early instars, mounted specimens quickly revealed their differences from that species and their similarity to the *scedastes* of the Old World. In the female there are six pairs of setae in the central area of the dorsal shield, rather than only two pairs as in *phalaenodectes*. On the hypostome there are only two rather than the usual three pairs. The genital shield is broadened posteriorly, bearing the genital setae on its margin, rather than being subrectangular and with the setae at a distance from its margins as in *phalaenodectes*. The males are less robust than those of *phalaenodectes*. They have four pairs of setae in the central area of the dorsal shield, and their chelicerae resemble those of the *scedastes* allotype male (from New Zealand), in striking contrast with the male chelicerae of *phalaenodectes*. Chaetotaxy of the legs agrees with that described for *scedastes*. The behavior of the Tyingham mites, both in forming bilateral colonies and in certain other respects, agrees with the observations of DAVIES (1969) on New Zealand specimens later determined as *scedastes*. It agrees also with what has been inferred from the study of dried hosts of this species. With these facts at hand it seems reasonable to regard the Old and New World material as conspecific, and in what follows I shall refer to these mites as *scedastes*. Because *scedastes*, despite its wide distribution, is but little known, and because its behavior raises interesting ecological, genetic, and evolutionary problems, I report my experience with the mites in considerable detail.

FERAL (i. e. NON-EXPERIMENTAL) HOSTS OF *D. scedastes*

Study of previously unmounted *Dicrocheles* from earlier collections and re-examination of all available material from my previously published records brought to light, as the earliest instances of *scedastes* thus far recognized in the New World, three examples from 1974, all from Tyingham. In the first instance the host was a male of the *Amathes c-nigrum* (Linnaeus) complex, taken at light on 20 June, 1974. Although my notes record my surprise at finding the countertympanic septum perforated and a gravid mite in the right countertympanic cavity while eggs were seen in the left tympanic air sac, I did not then mount any of the mites and they therefore remained unrecognized as *scedastes* until 15 December, 1975. Also unrecognized until about the same date were mites infesting a female of *Agroperina dubitans* Walker, taken on 11 September, and a female of *Amphipyra pyramidoides* Guenée taken on 6 October. In my book (*op. cit.*, 1975, pp. 308, 318) the last named moth species was listed erroneously as a host of *D. phalaenodectes*¹.

The earliest record for 1975, also unrecognized until weeks after the moth was collected, was from a male of *Leucania pseudargyria* Guenée taken in Tyingham on 9 July. Two living female mites and a few eggs were seen in the left tympanic recess and one female with eggs in the right. The moth was killed, pinned, and spread with its mites undisturbed. Upon dissection in the following September, two females of *D. phalaenodectes* were taken from the right tympanic air sac and countertympanic cavity respectively, and a female of *D. scedastes* from the left tympanic

1. Also erroneously cited as hosts of *D. phalaenodectes* are *Acronycta fimpessa* (pp. 307 and 318), *Catocala ultronia* (p. 167), *Polia c. contigua* (p. 319), and *Pseudoplusia includens* (pp. 311 and 319). To the listed hosts of *D. phalaenodectes* should be added *Lacinipolia lorea* (Guenée), and *Satyna privata* (Walker). From the new hosts listed in the note on page 167 the names *Apamea americana* and *A. velata* should be deleted, these having been previously recorded as hosts under the generic name *Amphipoea*. Attention is called also to the misspelling of the host name *Nedra ramosula* (Guenée), erroneously rendered "*ramulosa*" in Treat 1970 and 1975. Hosts of *D. scedastes* listed on page 319 of the book should include *Melanchra insignis*, *Persectania aversa* and *Plusia chalcites*, all reported by DAVIES (1969).

recess. This was the sole instance of the occurrence of the two species on a single feral host, but experimental infaunation yielded another example on host 38ab as described hereafter.

The above records and subsequent ones (excluding experimentally infaunated hosts) are summarized in Table I. All were from mixed "black" and incandescent light collections in Tyringham, Berkshire County, Massachusetts.

TABLE I. — Collection Data on Feral (i. e. non-experimental)
Hosts of *Dicrocheles scedastes* in Tyringham, Massachusetts

Date of Collection	Host Species and Sex	Serial No.	Status of Colony on Date of Collection*
1974			
20 June	<i>Amathes c-nigrum</i> complex, ♂	74-3	L++/R+
11 Sept.	<i>Agroperina dubitans</i> , ♀	74-22	R+
6 Oct.	<i>Amphipyra pyramidoides</i> , ♀	74-26	R+++
1975			
9 July	<i>Leucania pseudargyria</i> (Guenée), ♂	75-11	L++ (scd.)/ R+ (phal.)
29 Aug.	<i>Amphipyra pyramidoides</i> , ♀	75-38	LR++++
6 Sept.	<i>Crymodes devastator</i> (Brace),	75-41	L++/R+
12 Sept.	<i>Amphipyra pyramidoides</i> , ♀	75-44	none seen until later
27 Sept.	<i>Abagrotis atternata</i> (Grote), ♂	75-49	LR+++
14 Oct.	<i>Amathes c-nigrum</i> complex,	75-51	LR++++
20 Oct.	<i>Sunira bicolorago</i> (Gueneé), ♀	75-52	R++
21 Oct.	<i>Sunira bicolorago</i> , ♂	75-53	LR++
21 Oct.	<i>Amathes c-nigrum</i> complex, ♂	75-54	LR++
25 Oct.	<i>Amathes c-nigrum</i> complex, ♀	75-55	LR++++

*L, left ear; R, right ear; +, female(s) but no eggs; ++, unhatched eggs; +++, eggs and young; +++, young females in head region as well as in ear(s).

The summer of 1975 was noteworthy for a relatively high incidence of *Dicrocheles* infestations. In the taxonomically mixed but non-random sample of 950 moths examined, 139 (14.6 percent) carried mites of this genus. In 1974 the incidence was only 4.5 percent, and in 1973, 6.2 percent. Since the sampling in all years was biased in favor of hadenine genera such as *Leucania* and *Pseudaletia* that are the preferred hosts of *phalaenodectes*, these recorded incidences have only comparative value. More significant is the sample of 127 adults of the armyworm moth *Pseudaletia unipuncta* (Haworth) collected between 15 July and 28 October, 1975, in which the incidence of *Dicrocheles* was 27.5 percent, exceeding by 6.1 percentage points the overall incidence recorded

for this host during the shorter, peak season collecting periods of 1953 through 1957 (TREAT, 1958). During late July and early August of 1975 the weekly incidence in *P. unipuncta* was much greater, in some weeks as high as 96 percent. The presence of *scedastes* in Tyringham being unsuspected until September, most of the *Dicrocheles* seen there were assumed to be *phalaenodectes* and were not collected. While some colonies of *scedastes* may have been overlooked on this account, the seeming absence of bilateral infestations makes it likely that in most instances the mites were in fact *phalaenodectes*. Climatic conditions in Berkshire county during 1975 were marked by the highest precipitation on record. Although ear mites were abundant, the moth population, at least at my light, was somewhat below normal.

EXPERIMENTAL REARING OF *D. scedastes*

Infaunation of experimental hosts was easily accomplished by direct transfer of fertile females or by simple confinement of a mite-free moth in a stender dish with (1) a host carrying a mature colony, (2) questing female mites, or (3) flowers for which such mites had left a previous host. By the time that *scedastes* was recognized as such, the season was already late, and opportunities for experimentation were limited. Several experimental infaunations were attempted, however, and were successful in most instances as shown in Table II.

TABLE II. — Feral Donors and Experimental Recipients of *Dicrocheles scedastes*.

Feral Donor	Recipient/Donor		
	F ₁	F ₂	F ₃
38 <i>Amphipyra</i> <i>pyramidoides</i> , ♀	38a <i>Pseudaletia unipuncta</i> , ♀	38aa <i>P. unipuncta</i> , ♀	
	38b <i>Polia purpurissata</i> , ♂		
	38c <i>Crymodes devastator</i> , ♀		
	38e <i>P. unipuncta</i> , ♀	38ea <i>A. pyramidoides</i> , ♀	
	44a <i>P. unipuncta</i> , ♂	44ea <i>A. pyramidoides</i> , ♀	44eaa <i>P. unipuncta</i> ,
	44b <i>P. unipuncta</i> , ♀	44eb <i>Sunira bicolorago</i> , (Gn) ♀	
	44c <i>Peridroma saucia</i> (Hbn.), ♀	44ec <i>S. bicolorago</i> , ♀	
44 <i>Amphipyra</i> <i>pyramidoides</i> , ♂	44d <i>A. pyramidoides</i> , ♂	44ed <i>Lithophane grotei</i> Riley, ♂	
	44e <i>A. pyramidoides</i> , ♀	44ee <i>Eupsilia vinulenta</i> Grote, ♂	
	44f <i>P. unipuncta</i> , ♀	44ef <i>E. vinulenta</i> , ♀	
	44g <i>P. unipuncta</i> , ♂	44eg <i>P. unipuncta</i> , ♀	
		44eg <i>Amathes c-nigrum</i> complex, ♀	
51 <i>Amathes c-nigrum</i> complex, ♀	51a <i>P. unipuncta</i> , ♂		
	51b <i>P. unipuncta</i> , ♀		

Of the 26 experimental infaunations, 20 yielded bilateral colonies. In only 3 were the colonies unilateral. The host of one of the unilateral colonies (44d) was probably moribund when its mites were received, and died only three days later. Host 38ea, though repeatedly infaunated from two donors (38 and 41), remained apparently mite-free for a week, when a mite and eggs were found in the right TR. The eggs were removed successively for chromosome studies. Three days later the mite was dead, and although the host survived for 12 days more, the left ear remained unoccupied. On host 44ei, the brood female mite died about a week after infaunation leaving young in the right tympanic recess only. Hosts 44b and 44c appeared to be mite-free five days after infaunation, and were released. Later it became evident that the countertympanic cavities may in some instance contain many mites without there being any external sign of occupancy, wherefore it is uncertain whether hosts 44b and c were in fact free of mites when released. Hosts 44eh died apparently mite-free only two days after infaunation.

In the 20 other experimental hosts typical bilateral infestations developed. In ten instances the experimental colonies reached maturity and the experimental hosts were used as donors for a second experimental generation. In one instance (44eaa) a third experimental generation was produced.

The variety of feral as well as of experimental hosts shows little indication of host restriction or specificity. With the possible exception of *Peridroma saucia* (44c), tympanate noctuids of every species offered proved acceptable. There appears to be no strong preference if any for hadenine genera (*Leucania*, *Aletia*, *Pseudaletia*) most often infested by *phalaenodectes*. The frequent use of *Pseudaletia* as an experimental host reflects merely its late season availability.

Notwithstanding the bilaterality of typical infestations, injury to the host does not seem excessive. The 16 experimental hosts that were not killed for study survived for three to 24 (average ten) days after infaunation. Since the age of these moths at capture was unknown, no good experimental control was possible, but this survival period is about what might be expected for comparable mite-free moths under the same conditions. In general, the longer the host survived the greater became its load of mites.

The occurrence of *scedastes* in company with *phalaenodectes* on feral host (75-11 in Table I) has been noted above. Of special interest is the experimental infaunation with *scedastes* of a moth that, when collected, already carried *phalaenodectes* and also an interpalpal female of *Blattisocius tarsalis* (Berlese). This moth (number 38aa in Table II), a female of *Pseudaletia unipuncta*, was taken at the light on 29 August. The *Blattisocius* was removed immediately — the first mite of its species to be recorded from this host. At this time a single *phalaenodectes* female and two eggs were seen in the left tympanic recess. On 4 September two engorged females of *scedastes* were transferred directly to the moth, one from experimental host 38a (same species) and one from feral host 38, *Amphipyra pyramidoides*. Both mites wandered over the anterior parts of the moth, which soon brushed them off. They remained nearby, however, and must have re-embarked later. On 5 September the right tympanic recess was still unoccupied, and I transferred six young female wanderers from host 38, one directly to 38aa and five to the dish containing it. On the following day there were an engorged female with one egg in the right tympanic recess, a semi-engorged female behind the left patagium, and five unengorged females on the neck. Since by this time the *phalaenodectes* colony in the left ear was mature, it is likely that at least some of these young females were wanderers from that population. On this date (6 September) I removed and mounted six mites from the left tympanic recess. Four were *phalaenodectes* (two deutonymphs and two females); two were young females of *scedastes*. Before the next morning the host had died. Dissection showed several females in both tympanic areas. The left air sac was blackened and drying; it contained a few dead larvae and many exuviae.

The median countertympanic septum was perforated and a *phalaenodectes* male was in the opening, headed into the right countertympanic cavity, where there was a small fecal deposit but no mites. The right tympanic membrane was present but torn, and there was still one egg in the right recess. The right air sac was unoccupied. Six more mites were recovered : two *phalaenodectes* females, one deutonymph, and one male ; two *scedastes* females. Unfortunately the early death of the host precluded the opportunity of testing for possible hybridization, and no more *phalaenodectes* colonies appeared during the remainder of 1975.

STRUCTURAL DAMAGE TO THE HOST

Of special interest is the structural and sensory damage inflicted on the host by *Dicrocheles scedastes* as compared with that produced by *phalaenodectes*. By sparing one ear, *phalaenodectes* avoids depriving the moth completely of its chief means of eluding attack by bats. Although *scedastes* typically invades both ears, its approach is such that in most instances the tympanic membranes and acoustic sensilla are not destroyed. Tests with a Galton whistle showed that most infested moths could retain their acoustic sensitivity at least until their mite colonies were mature. If the tympanic air sacs were invaded they were usually entered via the uninervated countertympanic membrane, and their occupancy in the early stages of colony formation was restricted to the dorsomedial areas, leaving the primary acoustic structures undisturbed. Feeding punctures were made chiefly in the peripheral parts of the tympanic recess, around the margins of the countertympanic membrane, and on the dorsum of the first abdominal segment, although some might be found in the tympanic air sac as well. In most but not all instances one or both countertympanic membranes were destroyed. The median countertympanic septum was almost always widely perforated whereas in *phalaenodectes* colonies it remains intact. The countertympanic cavities had received the usual deposits of hygroscopic fecal matter mingled with exuviae, but in large colonies fecal matter could be found on the abdominal dorsum and elsewhere in the tympanic area as well as in the collar region when the young females had assembled there. In some instances the fecal deposits and the mites in the countertympanic cavities were found permeated by mold mycelia.

DEVELOPMENT AND COMPOSITION OF THE COLONIES

Since facilities for neither monitoring nor control of environmental conditions were available, the time course of colony development cannot be meaningfully described. Under the variable indoor conditions prevailing during September and October of 1975, an average of about 11 days, elapsed between infaunation and the appearance of questing F_1 females on the head of the host. This contrasts with the five days typically required for comparable development of *phalaenodectes* colonies during midsummer. Two to three days elapsed between infaunation and the appearance of eggs in the tympanic recess, though these eggs may not have been the first ones laid. A few timed observations of oviposition suggest that at room temperature eggs are laid singly at intervals of about six hours.

A colony census was attempted for two experimental hosts. Moth 51b, *Pseudaletia unipuncta*, ♀, was taken at the light on 15 October and on the following day confined with feral host 51, *Amathes c-nigrum* ♀. It was boarded by at least five female mites of which three were seen in the left and two in the right tympanic area on 19 October. On 27 October the moth was still

living and responding (somewhat inconsistently) to the Galton whistle. On this date it had five engorged females with young in the left and one with young in the right tympanic recess. There were several young females behind the right patagium, one under the base of the proboscis, and a few wandering in the culture dish. The moth was killed and injected, and stored with all its mites in alcohol for later study. On dissecting it several months later I counted 135 eggs and 170 post-embryonic instars. Of the latter I recovered and mounted 155 distributed as shown in Table III.

Experimental host number 44f, *Pseudaletia unipuncta*, ♀, was taken on or about 27 September and on 29 September was confined with goldenrod flowers carrying female wanderers from host number 44, *Amphipyra pyramidoides*, ♀. The number of mites that boarded the experimental host is unknown, but on 30 September a single engorged female was seen in each tympanic recess. On 2 October each recess contained 6 eggs and on 6 October both contained active young. On this latter date the Galton whistle elicited lurching and reaching movements by the moth, but by 8 October, no more responses could be evoked, although the right tympanic membrane and sensillum were later found to be intact. By 10 October five wanderers and one engorged female had left the moth and there were several young females on the neck. The moth was killed, injected and stored (with the recovered wanderers) in alcohol. On dissection I counted 127 eggs and 138 postembryonic instars. The anatomical distribution was as shown in Table IV.

In *scedastes* as in *phalaenodectes*, the ratio of males to females is low. Of the 155 postembryonic instars from host 51b, eleven (7 percent) were adult males. On host 44f I found 5 adult males (3.7 percent) among 139 postembryonic mites. Aceto-orcein squashes of some 56 embryos of various ages included none showing the numerous comma-like bodies reported (TREAT, 1965) in embryonic males of *phalaenodectes*. Most of the mitotic figures resembled those of female *phalaenodectes* embryos, the clearest and commonest showing six chromosomes, but some with seemingly higher or lower numbers. Figure 5d was prepared from freehand drawings made from various aceto-orcein squashes examined at 1350 × magnification under dark phase contrast illumination. Because of the limited depth of focus at this magnification, photographs of such specimens are less informative than careful drawings.

BEHAVIOR

The behavioral observations of DAVIES (1969), in New Zealand, on mites that were later described as *D. scedastes*, are in part confirmed by study of preserved specimens and of the New World material. Although he believed the tympanic air sacs to be unoccupied, dissections show that their more median parts may be invaded even though the tympanic membranes remain intact. Eggs, moreover, may be deposited not only in the tympanic recesses but in the other parts of the ear as well.

In many respects *scedastes* and *phalaenodectes* are similar in behavior as well as in appearance. The most striking differences are the usual sparing of the tympanic membranes by *scedastes*, the perforation of the median countertympanic septum, and the invasion of both ears. Dispersal and host seeking behavior are similar to *phalaenodectes*. Young, fertile females assemble on the head, neck, and collar of the host and leave, one or a few at a time via the proboscis or by other routes. Various autumn wildflowers proved attractive including those of phlox, goldenrod, and white snakeroot, but not the arrow-leaved aster. Even in the absence of flowers, however, fertile females would leave hosts that were confined in empty stender dishes. Such mites would wander and rest intermittently, often on the underside of the dish cover. On flowers, the mites often entered the corolla tube and remained there for some time.

TABLE III. — Post-embryonic Mites
Recovered from Experimental Host 51b.

Stage	Left Ear	Right Ear	On head or Free in vial	Total
Larva	15	13	1	29
Protonymph	17	21	--	38
Deutonymph	24	12	--	36
Molting D/♀	4	1?	--	5
Callow ♀	4	15	11	30
Engorged ♀	4	2	--	6
Male	5	6	--	11
Total	73	70	12	155

TABLE IV. — Anatomical Distribution of *Dicrocheles scedastes*
on Experimental Host 44f.

Stage	Site Occupied	Left	Right	Total
EGG	Tympanic recess	36	33	127
	Abdomen 1	8	0	
	Countertympanic cavity	10	10	
	Tympanic air sac	17	13	
	All sites			
POST-EMBRY- ONIC	Tympanic recess	20	29	143
	Abdomen 1	0	1	
	Countertympanic cavity	39	24	
	Tympanic air sac	2	3	
	On head end or free in vial	--	--	
	All sites			
ALL STAGES		132	113	265

In view of the usual behavioral pattern of *phalaenodectes* in seeking and "choosing" a unilateral site for the establishment of its colony (TREAT, 1957) it could be expected that some modification of this procedure would be observed in *scedastes*. Neither Davies nor I have seen any instance of the midline passage down the thoracic disc or the probing and shuttling at the inter-tympanic "crossroad" so typical of *phalaenodectes* females. On 21 October, after many hours of fruitless watching for this performance on unrestrained moths at rest in stender dishes on previous days, I placed a mite-free female of *Pseudaletia unipuncta* (No. 44eaa) in a transparent plastic box measuring $50 \times 40 \times 15$ mm, where, partly with the aid of a mirror, I could keep in clear view all but the subalar surfaces of the insect. To the anterior thoracic tuft of this moth I transferred two young *scedastes* females from experimental host 44ea, one at 2 : 50 PM from the culture dish in which it was wandering, and one at 3 : 30 PM from a white snakeroot flower for which it had left its original host. Both mites buried themselves in the anterior vestiture and for some time could be located there by the frequent disturbances of the hair scales caused by their jerky, thrusting movements. After 4 : 15 PM the mites could no longer be traced. The resting moth was kept under continuous observation from all sides. At about 5 PM it displayed a series of intermittent jerks or kicks of the mesothoracic legs, suggesting some local irritation. At 6 : 40 PM the moth became active. I immediately immobilized it with carbon dioxide, and found one mite in and another at the periphery of the left tympanic recess. There had been no midline passage and no traceable course dorsally, ventrally or laterally. Since the only parts of the moth that were obscured from view were those portions of its sides that were covered by the folded wings, it seems likely that the route from the collar region to the tympanic recess was subalar. By 27 October, when it was killed and dissected, the moth had a typical bilateral infestation.

Certain aspects of the mites' behavior within the colony are implicit in what has been written above concerning rearing experiments and structural damage to the host. The acts of feeding, defecation, and oviposition are generally similar to those performed by *phalaenodectes*. Some details can be added to previously published accounts from notes made during several hours' continuous observation of a single ovipositing female in the left tympanic recess of *Pseudaletia unipuncta*, experimental host 51a, on 19 October. Five eggs had already been laid on the conjunctiva of the ear. Feeding scars were evident at the ventral border of the conjunctiva and around the spiracle at the base of the hood. They appeared black and beaded with several minute globules probably of coagulated hemolymph. Revisits to these places by the mite, and close applications of her mouthparts to them suggested possible reopening of initial punctures. Observation under $180 \times$ stereoscopic magnification showed that both the gnathosoma and the anal region are almost fully retractable, the latter in three telescopic sections of which the outermost encloses the anal shield. During defecation, which took place at intervals of about 35 minutes, the anal region was erected into a conical form from whose summit the minute, transparent anal papilla was protruded. A few seconds after the fecal droplet had been voided, the papilla was withdrawn from it and the cone was gradually flattened. Of the fecal droplets voided during this period of observation, the first four or five were large and water white, shrinking at a perceptible rate to turbid white spheres. Later droplets, perhaps because of the drying effect of the illuminator, were smaller, yellow, and almost non-shrinking. One such droplet rapidly coalesced with a droplet of water brought into contact with it experimentally. It is interesting to consider the possible regulatory effect of the apparently hygroscopic fecal deposits upon the microclimate of the colony (see also HAZAN, GERSON, and TAHORI, 1975).

Gravid female mites become greatly engorged, the hysterosoma at this stage becoming somewhat broader relative to the rest of the body than in *phalaenodectes*, but flatter rather than

cylindrical. Preparation of sites for egg laying, the depositing of the eggs, and subsequent behavior toward them are all much as in *phalaenodectes*.

I have not yet witnessed ecdysis or copulation in *scedastes*. Pairs taken in copula from preserved material have always drifted apart when mounted for study, giving no certain indication of the site or mode of insemination.

REVIEW OF EARLIER RECORDS

The unexpected finding of *D. scedastes* in Tyringham made it seem advisable to review New World material from other localities in order to make sure that the species had not been overlooked through confusion with *phalaenodectes*. While not all of the relevant specimens are now available to me, I was able to confirm the diagnosis of *phalaenodectes* in all but a few of the previously published host records. In the absence of specimens, verification is lacking at present for the following hosts (see also footnote 1) : *Faronta albilinea*, *Feltia herilis*, *Leucania flabilis*, *L. imperfecta*, *L. linda*, *L. multilinea lapidaria*, *Pseudaletia unipuncta antica*, *Syngrapha epigaea*. Since the records reported for these hosts (TREAT, 1970, 1975) included none where bilateral colonies were in evidence, there is nothing to suggest that the mites were *D. scedastes* in these or in any other New World host except for those of the Tyringham collections here discussed. In one instance, however, a mite colony previously recorded as *phalaenodectes* proved to represent a hitherto undescribed species. The host was identified by the collector, Philip S. CALLAHAN, as *Pseudoplusia includens* (Walker). The moth was a male, taken 28-30 August, 1975, in a light trap at Baton Rouge, Louisiana. It was preserved in formalin and was sent to me (with much other valuable material) by Dr. CALLAHAN in 1959. I offer the following description of the mites.

Dicrocheles hippeoides, n. sp.

Synonym : *Dicrocheles phalaenodectes*, Treat, 1970, 1975.

DIAGNOSIS : Both sexes with six pairs of long setae in the central area of the dorsal shield (not counting 11 at its anterior margin), in females averaging about 56 μ m, in males about 32 μ m ; genital shield of female subrectangular with setae on the soft integument as in *phalaenodectes* ; males with chelae resembling those of *phalaenodectes*.

FEMALE (fig. 1, 2). Gnathosoma like that of *phalaenodectes*. Basal cheliceral segment 18 μ m, distal 75 μ m long to base of movable digit ; fixed digit tapered, flattened, shorter than movable digit and flanking it laterally ; movable digit upcurved, pointed, about 21 μ m long and with strong secondary tooth as in *phalaenodectes* ; salivary stylets present ; corniculi short, stout, rounded at tips ; internal malae slender, delicate, pointed ; number of posterior hypostomal setae variable, one on left and two on right side in holotype, two on left and one on right in paratype ; at least 12 rows of six to twelve deutosternal denticles ; capitular setae present ; palpal trochanter with one, femur with four setae.

Dorsal shield (fig. 1) irregularly pear-shaped, narrowly tapered posteriorly, 290 μ m long, 170 μ m at widest, with 11 pairs of simple setae averaging about 56 μ m long ; about 60 setae

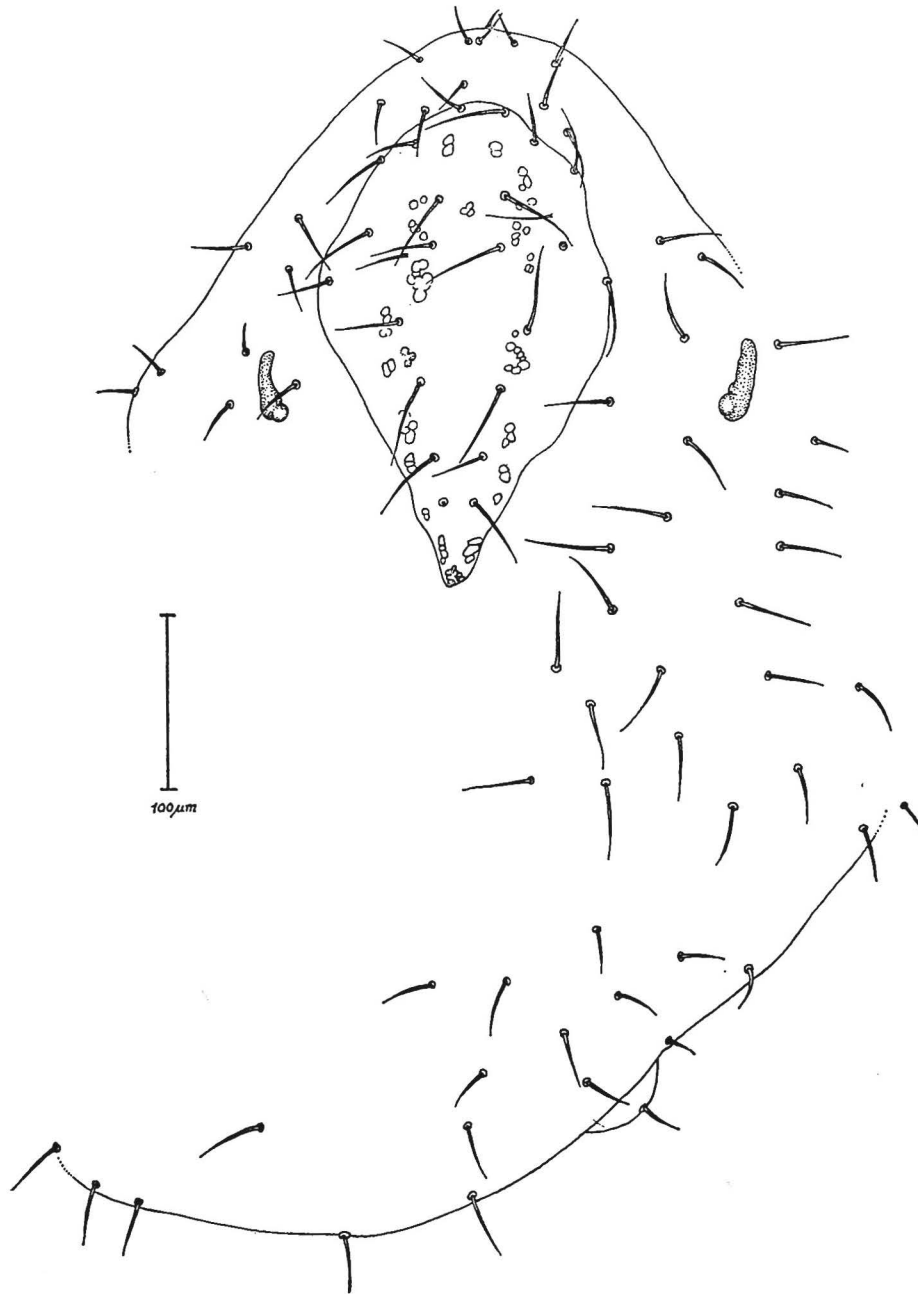


FIG. 1. — *Dicrocheles hippeoides*, holotype, engorged female,
cuticle cleared in KOH and mounted prone : dorsal aspect of idiosoma,
ruptured in preparation.



FIG. 2. — *Dicrocheles hippeoides*, holotype female as in fig. 1 : ventral aspect as seen in prone mount.

(30 pairs ?) on soft integument of dorsal and lateral surfaces ; peritremes about 45 μ m long, extending to about mid-level of coxae III. Tritosternum (fig. 2) with simple lacinia extending nearly to posterior hypostomal setae ; sternal shield squarish, with three pairs of long sternal setae ; genital shield similar to that of *phalaenodectes*, anterior portion tongue-shaped with central ridge giving off short, divergent furrows, posterior part subrectangular, slightly rounded posteriorly ; genital setae on soft integument ; anal shield terminal, with para- and post-anal setae and three or four additional setae on anterior margin ; about 48 (24 pairs ?) of opisthosomal setae on soft ventral integument.

All legs with pretarsi, small claws and caruncles. Setal numbers on coxae to tibiae respectively as follows (numbers in some cases doubtful or variable) : leg I, 2, 4, 11 ?, 7-9 ; leg II, 2, 5 I, 8 ?, 7, 7 ; leg III, 2, 5, 5, 7, 7 ; leg IV, 1, 4, 6, 7, 7. All tarsi with ventral lyriform fissures.

MALE (fig. 3). Chelicerae (fig. 3d, c) resembling those of *phalaenodectes*, basal segment 17, distal 53 μ m, chelae and spermadactyl as figured ; salivary stylets present ; corniculi short, blunt, a minute hooked process at base of each possibly representing internal malae ; two pairs of hypostomal setae in allotype male, three in paratype ; 17 rows of 10 to 20 deutosternal denticles ; number of setae on palpal coxae to tibia 1, 1, 4, 4, 7 respectively ; tectum capituli (epistome, fig. 3a) smoothly rounded.

Idiosoma about 350 μ m long ; 200 μ m at widest, shape as figured ; dorsal shield (fig. 3a) about 290 μ m long, 170 μ m at widest, indistinct in both specimens, with setation probably as in female except setae averaging only 32 μ m ; about 15 pairs of setae on dorsal and lateral soft integument, probably as in protonymph ; peritremes 25 μ m long, not reaching mid-level of coxae III. Tritosternum (fig. 3b) only about 20 μ m from base to tips of lacinia ; ventral sclerotization indistinct, setation of allotype as shown ; anal shield with some setae cleft (in allotype) or branching (in paratype, fig. 3e) at tips.

Legs with short or retractile pretarsus and stout claws, caruncles if present not seen. Setal numbers on coxae to tibiae respectively as follows : leg I, 2, 5, 11, 7-9, 8 ; leg II, 2, 4, 9, 6, 7 ; leg III, 2, 4, 5, 6, 7 ; leg IV, 1, 4, 4 ?, 7 ?, 7 ; tarsi II, III, and IV each ventrally with three blunt conical or nipple-like structures (fig. 3f) ¹ ; all tarsi with ventral lyriform fissures.

EGG (mounted). Subglobular 215 \times 196 μ m.

LARVA (fig. 4a, b). As figured ; two pairs of hypostomal setae ; palpal setae coxae to genua, 0, 0, 2, 0 ? ; sclerotization very slight but suggesting divided dorsal shield ; several ventral setae cleft or tufted at tips ; all legs with sessile claws ; setal numbers on coxae to tibiae respectively as follows : leg I, 2, 4, 7-10, 8, 8 ; leg II, 2, 4, 6-7, 6, 7 ; leg III, 2, 4, 5-8, 6, 7. Distal rows of minute cuticular denticles dorsally on palpal coxa, coxa I, and trochanters I and II.

PROTONYMPH (fig. 4c, d). As figured ; two pairs of hypostomal setae ; palpal setae, coxae to genua, 1, 0, 2, 4 ; 13 rows of deutosternal denticles (not figured) ; about 21 pairs of dorsal and lateral setae ; peritremes emergent ; four pairs of ventral opisthosomal setae, second pair and paranal setae cleft or tufted at tips ; all legs with sessile claws ; setal numbers coxae to tibiae as follows : leg I, 2, 3-4, 7-10, 8, 8 ; leg II, 2, 4, 7-8, 6, 7 ; leg III, 2, 4, 5, 6, 7 ; leg IV, 0, 4, 3-4, 6, 7.

1. Though not previously noted, such structures are also present on males of the other species of *Dicrocheles*.

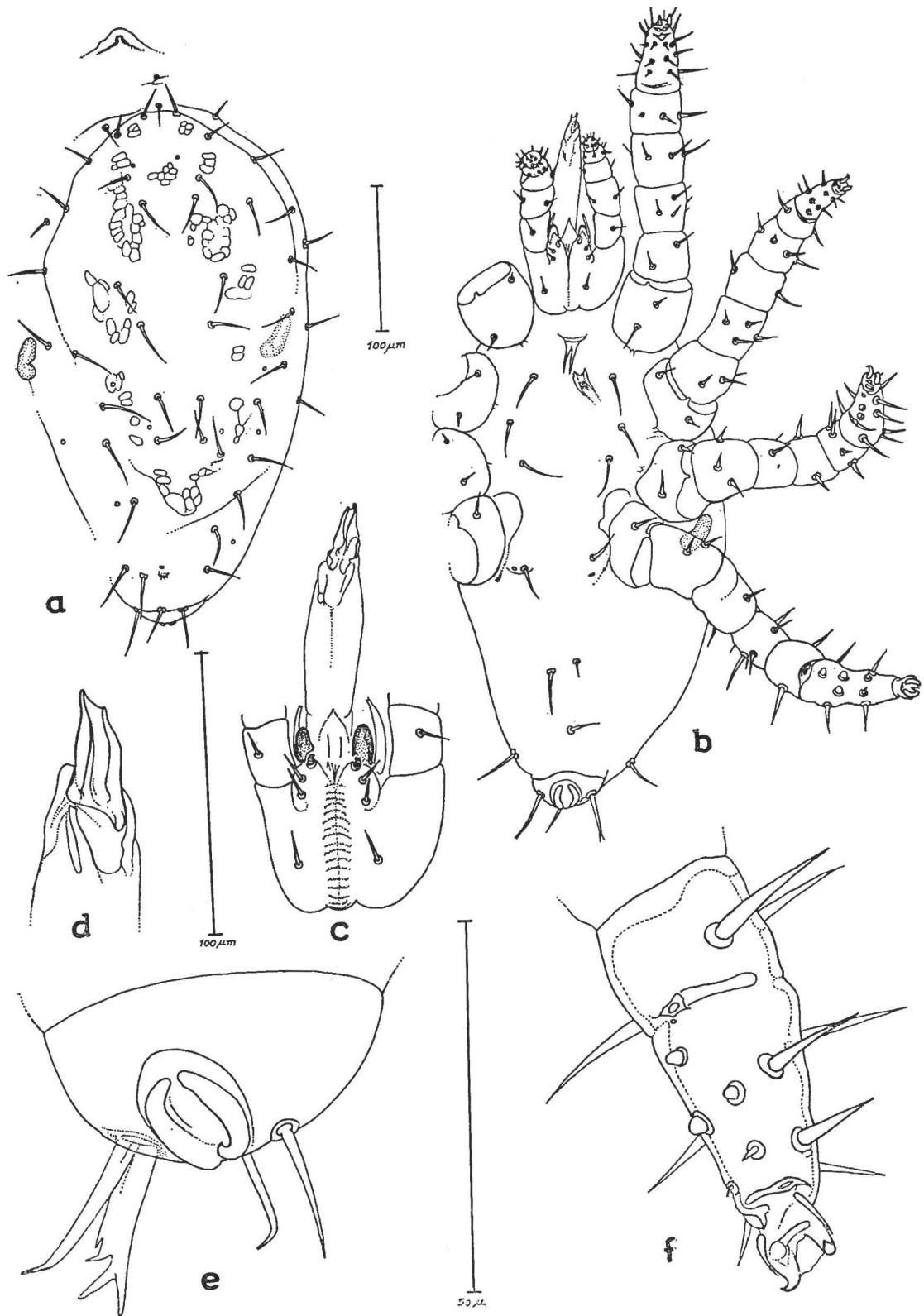


FIG. 3. — *Dicrocheles hippeoides*, male : a, dorsal aspect of idiosoma and tectum capituli of allotype as seen in supine mount ; b, ventral aspect of allotype ; c, ventral aspect of gnathosoma of allotype (the left chelicera is lacking in the mounted specimen) ; d, ventral aspect of tip of left chelicera of paratype (scale as for e and f) ; e, ventral aspect of anal shield of paratype, showing aberrant setae ; f, posteroventral aspect of left tarsus III of allotype.

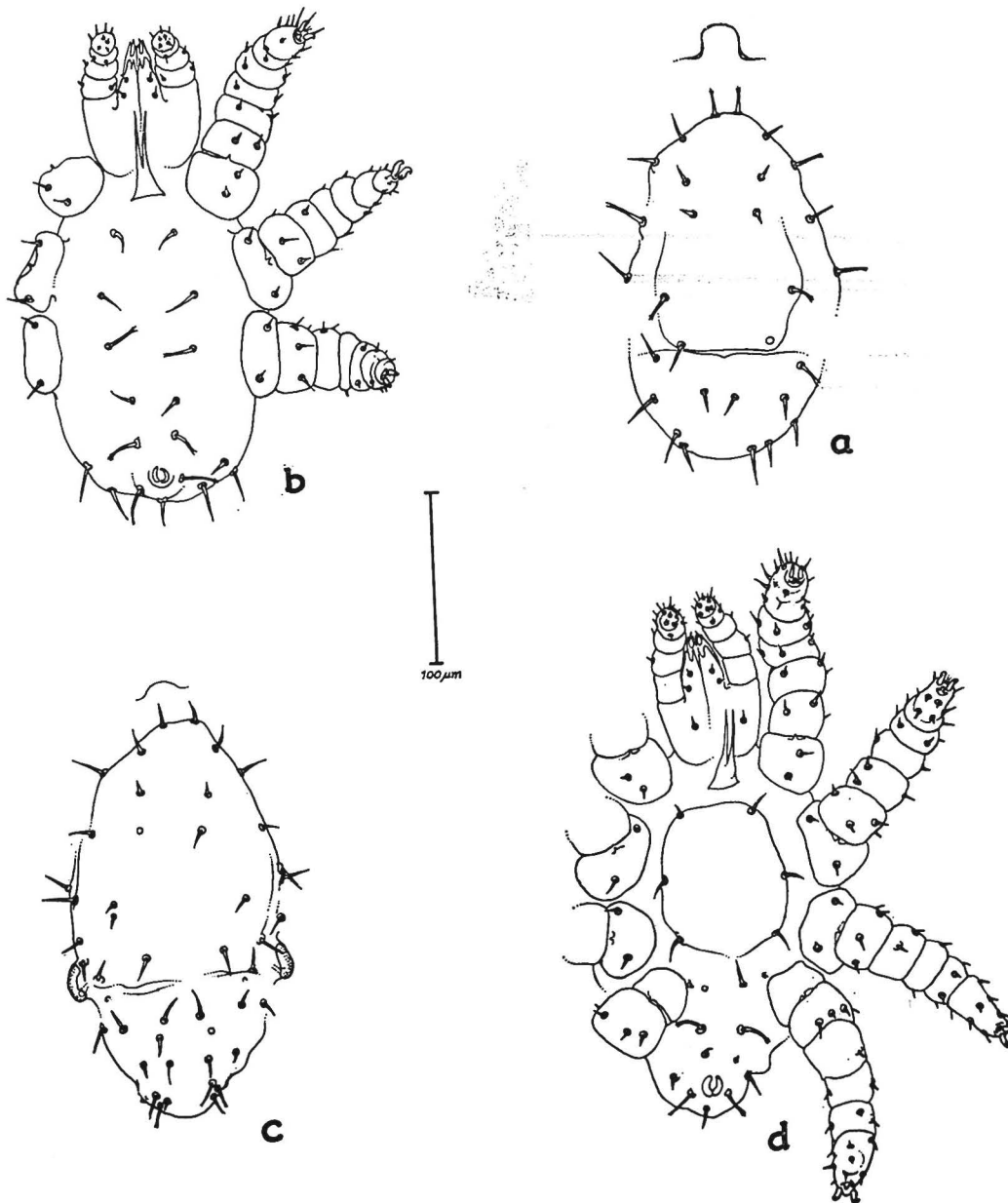


FIG. 4. — *Dicrocheles hippeoides* : a, dorsal aspect of idiosoma and tectum capituli of larva ; b, ventral aspect of same larva as seen in supine mount ; c, dorsal aspect of idiosoma and tectum capituli of protonymph as seen in supine mount ; d, ventral aspect of same protonymph.

DEUTONYMPH (fig. 5a-c). As figured ; three pairs of hypostomal setae in most specimens, two or two/three in some ; palpal setae, coxae to genua, 1, 1, 4 ?, about 14 rows of deutosternal denticles ; sclerotization of idiosoma indistinct ; about 25 pairs of dorsal and lateral setae ; all setae simple ; all legs with sessile claws ; setal numbers on coxae to tibia respectively as follows : leg I, 2, 4, 10, 8, 8 ; leg II, 2, 4, 7-8, 6, 7 ; leg III, 2, 4, 5 ?, 6, 7 ; leg IV, 1, 4, 4, 6, 7.

TYPE MATERIAL. The type series comprises the holotype and one paratype female, the allotype and one paratype male, 4 molting deutonymph ♀♀ ; 12 deutonymphs, 2 molting proto-/deutonymphs ; 17 protonymphs, 5 larvae, and 2 eggs. These are mounted in Hoyer's medium on seven slides to be deposited in the American Museum of Natural History. Because the mites were preserved in formalin when received, ordinary methods of clearing were ineffective. I therefore heated them in KOH solution before washing and mounting. This, while clearing most of the specimens, softened the cuticle so much that they were difficult to handle and subject to much distortion during and after mounting. Dimensions given in the above description are therefore only approximate. All specimens are from a dealated and dissected host determined by the collector and now preserved in alcohol in my collection. Collection data precede the above description. Though suggested by the long dorsal setae, the name *hippeoides* is derived from the Greek ἵππεύς, a rider.

DISTRIBUTION ON HOST. The mites were found in the right tympanic air sac, under the right metascutum, and in the right accessory tympanic chamber (pocket IV of RICHARDS, 1933), which was crowded with mites and contained also a small, compact, fecal deposit. The counter-tympanic cavity, left ear, and all other parts of the moth were unoccupied. Pocket IV, which is greatly enlarged in this and other plasiines, had evidently, served the mites much as does the countertympanic cavity in *phalaenodectes* colonies.

DISCUSSION

Although *Dicrocheles phalaenodectes* is widespread in the Western Hemisphere and has yet to be reported from the Eastern, the findings here related clearly deprive it of any claim to being the sole New World representative of its genus. The discovery of what appears to be the Old World *scedastes* in Tyringham, the type locality of *phalaenodectes*, is less surprising than it may seem. It could indicate nothing more than the long neglect that these mites have enjoyed — their almost total immunity from the attentions of collectors both of mites and of moths. A communicative bat with a sufficiently sensitive palate might tell us that *scedastes* and perhaps several other distinctively flavored species have been with us for years. It is possible, of course, that some Old World *scedastes* have skedaddled westward, and that they are newcomers to our fauna. In that event their first recognition in Tyringham would be a singular coincidence indeed. Surely, in view of the known or suspected migratory habits and agricultural importance of some of their hosts, the distribution of such mites deserves more careful and extensive study than it has received in the twenty-five years since their discovery. Such study, however, is not within the province or capacity of a single collector ; a concerted undertaking would be needed, including a network of light traps and the release and recovery of marked specimens.

The occurrence of *scedastes* on the same host and even in the same ear with *phalaenodectes*, and the discovery of a population combining certain characteristics of the two species, raise questions regarding their reproductive isolation and the possibility of hybridization. Bearing upon

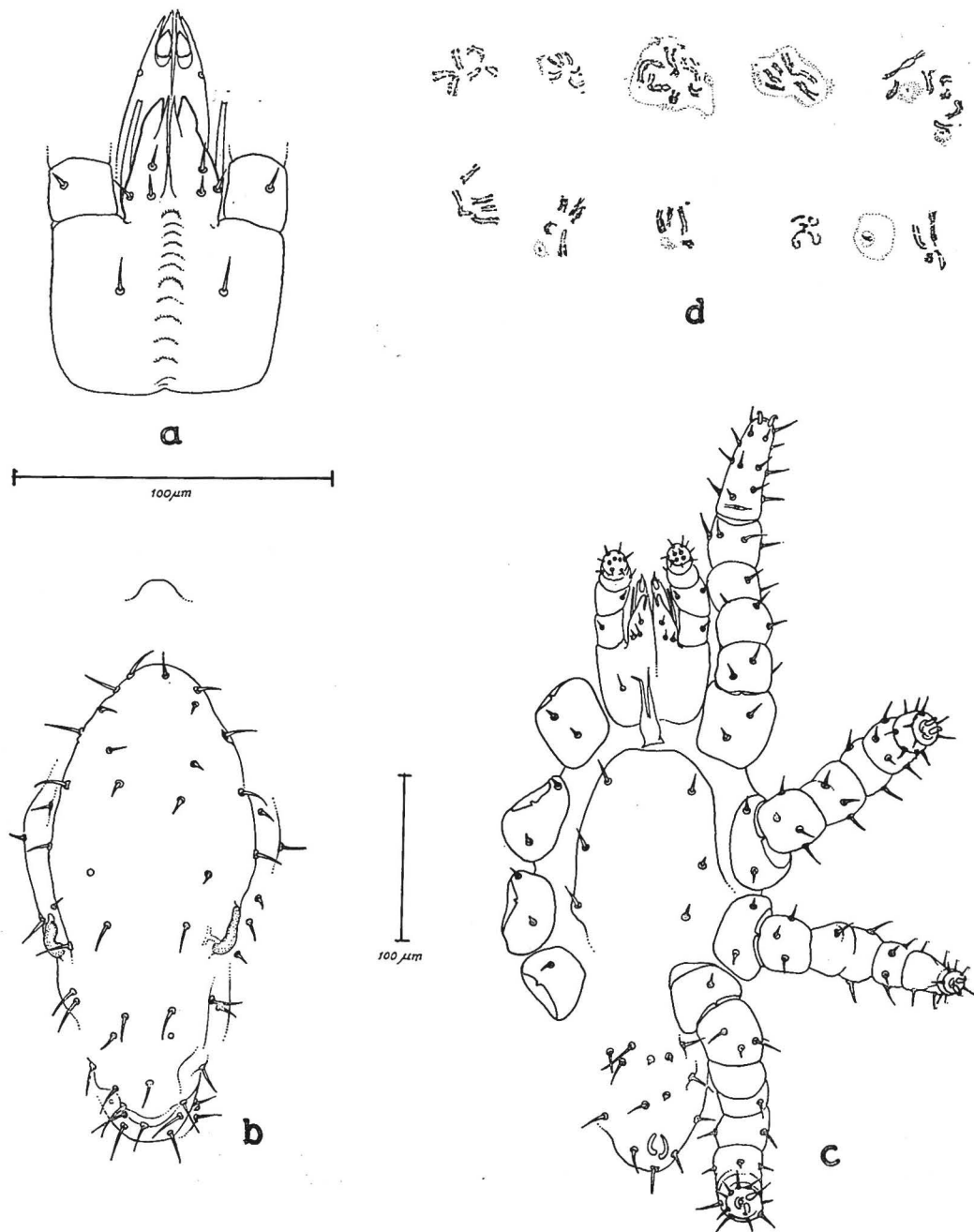


FIG. 5 a-c. — *Dicrocheles hippeoides*, deutonymph : a) ventral aspect of gnathosoma as seen in supine mount ; b) dorsal aspect of idiosoma and tectum capituli ; c) ventral aspect of same deutonymph as seen in prone mount.

FIG. 5 d. — *Dicrocheles scedastes*, freehand drawings of chromosomes as seen under phase contrast at 1350 × magnification in aceto-orcein squashes of 24- to 48-hour embryos from the right tympanic recess of host 51a ; the drawings are not to scale.

these questions could be the conspicuous difference between the species in the form of the male chelicerae. Despite the apparent mingling of some characters and the variability of others in *D. hippeoides*, it seems unlikely that the type series represents a hybrid population. Although the number and arrangement of dorsal setae does suggest the three known Old World forms, the greater length of these (more than double that in any other known species) is not readily explained as the result of a cross. Continuous experimental culture of hosts and mites would contribute to the solution of such problems, but is not practicable in my circumstances.

Questions of evolutionary origin and divergence, of population dynamics, and of selection pressures in the ecological context of bat versus moth predation may well engage the attention of future students.

I thank Dr. Philip S. CALLAHAN of the United States Department of Agriculture for his kindness in collecting, examining, preserving, and sending to me the host of *D. hippeoides* and much other valuable material. I thank Dr. Philippa Claude STRETTON for preparing the French translation of the abstract.

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ADDENDUM

In 1976, during the summer following the submission of this paper, I collected 91 moths carrying *D. scedastes* only, 10 carrying *D. phalaenodectes* only, and 8 carrying both species, all verified from mounted specimens. In 1977 the situation was reversed : 103 moths carried *phalaenodectes* only, 2 carried *scedastes* only, and 2 carried both species. For this striking shift in populations I can at present offer no explanation.

Paru en Mars 1978.
