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MITES ASSOCIATED WITH BRITISH SPECIES OF ORNITHOMYA

(DIPTERA: HIPPOBOSCIDAE)

By D. S. Hill,[1] Nixon Wilson[2] and G. B. Corbet[3]

Abstract: The ♀♀ of *Strelkoviacarus quadratus* (Haller), *S. critesi* Spory, *Microlichus avus* (Trouessart), *Mi. uncus* Vitzthum, *Myialges macdonaldi* Evans et al. and *My. anchora* Sergent & Trouessart are redescribed, illustrated and keyed. The first five species were collected at Gibraltar Point and Fair Isle Bird Observatories, Britain, from *Ornithomya* flies taken from birds. *My. anchora* is included on the basis of records in the literature. Only adult ♀♀ mites were collected from flies. Different birds, and sometimes different flies, were preferred as hosts by the various mites. The mites were topographically separated on the flies. Some were invariably accompanied by eggs, while others were not. Also, there were definite seasonal variations in abundance which generally correlated with the seasonal occurrence of the flies on the hosts. All of the mites are assumed to be primarily skin or feather parasites of birds. In some cases adult ♀♀ are phoretic on the flies whereas in others they are hyperparasitic. The association of mites-flies-birds is the chief means of dispersal of mites from bird to bird.

Numerous observations of mites have been reported from hippoboscid flies taken from wild birds. Many records are of little value because of misidentification of flies and taxonomic confusion of mites. Some aspects of the ecology and life history of the mites have been studied, but these often conflict and some appear to be without any factual basis.

This association between mites, hippoboscids and birds is probably unique, and is of much interest parasitologically. The mite genera concerned are *Microlichus* Trouessart & Neumann, *Myialges* Sergent & Trouessart and *Strelkoviacarus* Dubinin. The mites found on the flies were invariably adult females. The taxonomic confusion over the genera and species involved has been considerable with some authors placing them in one family (Dubinin 1953; Furman & Tarshis 1953; Fain 1957; Evans et al. 1961) and others prefering two or more separate families (Vitzthum 1942; Baker & Wharton 1952; Fain pers. comm.). Bequaert (1953) suggested that all the mites from Hippoboscidae may be species of the genus *Microlichus*. Bequaert (1953) remarked on the probable life history of the mites, "After mating on the bird, some or possibly all females migrate to Hippoboscidae, where they attach to the integument, become fully gravid and eventually oviposit, the eggs clustering around the mother mite. After hatching from the egg, the mite larva probably returns to a bird before starting to feed. In this manner a fly infested with mites may transfer larvae to a new bird, particularly to nestlings, and this possibly may be the normal mode of dispersal of most species of *Microlichus*." However, he stressed that more information was required before any such account could be validated. Here Evans et al. (1961) is followed in placing the three genera in the family Epidermoptidae, order Astigmata. These have been recorded from numerous hippoboscid flies and Mallophaga, and from a wide range of birds throughout the tropical and temperate regions of the world. Several other species of mites also have been found on bird flies, but they are either predatory forms or species with scavenging habits and renowned for their ubiquitous distributions. They are not considered important to the present study. The two most extensive works on these mites are by Bequaert (1953) and Dubinin (1953), the latter including some ecological data with his taxonomic results. Recently, the first major contribution to knowledge of the life history of *Myialges* was made by Evans et al. (1963) when they found two birds (*Parus caeruleus* from England; *Leiothrix lutea* from Japan) infested with both flies and mites. The mites, a new species (*My. macdonaldi*), were found in conspicuous skin lesions on the birds as well as on the flies. Numerous immature stages, males and four young females were collected from the skin of the birds; gravid females surrounded by eggs were found exclusively on the hippoboscids. The males and immature stages were typically *Sarcoptes*-like with short stout legs and strong dorsal spines, and presented a striking contrast to the long legged, spineless females.

[1]Commonwealth Institute of Entomology, London (formerly with Department of Zoology, University of Hong Kong).

[2]B.P. Bishop Museum, Honolulu, Hawaii 96819. Supported in part by US Public Health Service research grant AI-01723 from the National Institute of Allergy and Infectious Disease, National Institutes of Health.

[3]British Museum (Natural History).

Immature stages and males of *Myialges anchora* and *Microlichus uncus* have yet to be found, although males of *Microlichus avus* and *Strelkoviacarus quadratus* have been recorded from a wide range of birds (Dubinin 1953). Males, females and a nymph of *Strelkoviacarus critesi* were reported from an icterid (Spory 1965).

An attempt to start a thorough investigation into the association between mites, flies and birds can be made only in a place where there is no taxonomic confusion over the hippoboscid flies and where it is relatively easy to distinguish between resident and migrant birds. To this extent the British Isles is an ideal location for such a study, since there are only five common bird flies present and each is confined largely to a different group of birds. This paper establishes a foundation of data which later may permit a full analysis of host relations, distribution and life histories of these mites. The six mites concerned in the British Isles are redescribed and illustrated in order to facilitate future work on this topic.

METHODS

Field work was carried out by Hill at the Gibraltar Point Bird Observatory and Field Research Station, Lincolnshire, from 11.VIII–24.IX.1957, 1.VI–30.IX.1958, and 16.VI–30.IX.1959. The work at Fair Isle Bird Observatory, Shetland, was performed by Corbet from 1953–55.

The birds used in these projects were mostly breeding or had been bred in the areas concerned and were trapped in Heligoland or small Potter traps. The advantage of these traps is that the flies did not leave the birds. The flies were collected from birds using a Fair Isle delousing apparatus (Williamson 1954). Effectiveness of this device was 100% in removal of hippoboscids, very good for fleas, but only fair for Mallophaga and Acarina. The anesthetized flies were examined immediately after collection. The number of mites observed on the flies, and their positions, was noted before samples were preserved in 70% alcohol.

For recording purposes, the mites were assigned to one of several categories. Subsequent examination of the collected specimens, which totalled almost half the number recorded, revealed a good correlation between the arbitrary categories and different species of mites.

The few mites that fell from the birds' plumage in the delousing chamber were collected and details of these are given in TABLE 1.

Measurements are the mean of five specimens unless noted otherwise. The width was measured in the region of the humeral setae except in gravid *My. macdonaldi* which were measured at the widest point of the hysterosoma. *My. anchora* was redescribed and illustrated from specimens collected in the United States.

RESULTS

The species of flies collected at Gibraltar Point were *Ornithomya fringillina* Curtis, *O. chloropus* Bergroth (=*O. lagopodis* Sharp [Hill 1964]), and *O. avicularia* (L.), whereas at Fair Isle only *O. chloropus* was found on the resident birds.

The mites involved at Gibraltar Point, arranged in their order of abundance, were *Strelkoviacarus critesi* Spory, *Myialges macdonaldi* Evans et al., *Microlichus avus* (Trouessart), *Tyrophagus* sp., *Blattisocius dentriticus* (Berlese) and a species belonging to the family Erythraeidae. Those at Fair Isle were *S. quadratus* (Haller), *Mi. avus*, *Mi. uncus* Vitzthum and *Proctophyllodes hipposideros* Gaud. Corbet (1961) subsequently listed *My. anchora* Sergent & Trouessart and *Acarus siro* L. from *O. avicularia* at Romford, Essex.

Only *Mi. avus*, *Mi. uncus*, *My. anchora*, *My. macdonaldi*, *S. critesi* and *S. quadratus* are regarded as normal British bird fly mites; the others are regarded as accidental stragglers and of little importance. In these six species there were never any males found on the flies; whereas in the other species of mites males were frequently recorded.

TABLE 1. Acarina collected from birds at Fair Isle, 1953–55, and Gibraltar Point, 1957–59.

Locality Host	Date	Source	Acarina
FAIR ISLE			
Starling (*Sturnus vulgaris* L.)	7.VIII.1955	fell from body in	*Analges corvinus* Robin
Rock pipit (*Anthus spinoletta* (L.))	7.VIII.1955	delousing apparatus	*Proctophyllodes anthi* Vitzthum
GIBRALTAR POINT			
Linnet (*Carduelis cannabina* L.)	9.VI.1958	fell from body in	*Ornithonyssus sylviarum* (Can. & Fanz.)
Chaffinch (*Fringilla coelebs* L.)	4.VII.1958	delousing apparatus	*Monojoubertia microphylla* (Robin)
Whitethroat (*Sylvia communis* Lath.)	7.VII.1958		*Ornithonyssus sylviarum*
Whitethroat	25.IX.1958	from gape and eyelid	*Ixodes ricinus* (L.)
Blackbird (*Turdus merula* L.)	30.VII.1959		*Ixodes ricinus*

SPECIES OF MITES

Microlichus avus (Trouessart) FIG. 1.

Chorioptes avus Troues., 1887, Compt. Rend. Acad. Sci. **104**(13):922.

♀. *Body*: Nongravid specimens, length of idiosoma 162 μ; including gnathosoma, 213μ; width 142 μ; cuticle striated dorsally and ventrally except on propodosoma. *Dorsum*: Line between propodosoma and hysterosoma present; propodosomal plate irregularly hexagonal, 51μ long, 52μ wide; 1 pr indistinct pores in anterolateral area, finely granulated pattern; 2 prs scapular setae on posterolateral, indefinite extensions of propodosomal plate—inner pr 21 μ long, outer pr 92 μ long; small pair linear plates posterior to inner scapular setae, sometimes connected to indefinite extensions of propodosomal plate; ventral apodemes of legs I-III extend to dorsum, appear as small dark plates on margin of propodosoma opposite legs I-III; plate overlying bases of legs II-III; that over leg III with 3 humeral setae, inner and outer seta subequal, about half as long as middle seta which is shorter than leg III; outer seta lateral or lateroventral; hysterosomal plate divided longitudinally, irregularly rectangular, 65 μ long, 36 μ wide, 2 prs long, fine setae and 1 pr minute setae and oil gland pores on outer margin, 1 pr minute setae posteromedian; 1 pr setae flanking paired anal plates; anal groove posterior, extending slightly dorsally and ventrally; spermatheca, bursa copulatrix and canal above and between anal setae, canal usually with 1 loop.

Venter: Apodemes of coxae I converge near tip without joining, then diverge; apodemes of coxae II long, extending past tips of epigynium; apodemes of coxae III-IV shorter than I-II, with breaks in surface; coxae I and III with a long fine seta; epigynium crescent-shape, wide and narrow, tips 25 μ apart; genital lobes an inverse V with seta and notch on outer posterolateral margin; 1 pr setae anterolateral to genital lobes; 6 prs opisthosomal setae—1 pr median, 3 prs in horizontal submarginal row, 2 prs on posterior body margin on tubercles with outer pair stout, 174 μ long, inner pair fine, 65 μ long; a small linear plate extends inward from tip of apodeme III and 2 plates outline posterior border of coxa IV. *Gnathosoma*: Chelicera 31 μ long; palps dorsally with 1 long seta anteriorly and 1 short seta posteriorly, ventrally with 2 setae of about equal length. *Legs*: I-II stouter and shorter than III-IV; tarsal claws stoutest on legs I-II, weakest on III-IV; tarsi with subglobular; entire caruncle on pedicel about 1/3 total length of caruncle; chaetotaxy as illustrated.

One specimen had the hysterosomal plates slightly united anteriorly.

Microlichus uncus Vitzthum FIG. 2.

Microlichus uncus Vitz., 1934, Bull. Mus. Roy. Hist. Nat. Belg. **10**(12):1–20.

♀. One nongravid specimen measured. *Body*: Nongravid specimen, length of idiosoma, 291 μ; including gnathosoma, 329 μ; width, 212 μ; gravid specimens, length of idiosoma, 422 μ; including gnathosoma, 471 μ; width 279 μ; cuticle finely striated dorsally and ventrally except around anal groove. *Dorsum*: Line between propodosoma and hysterosoma present, sometimes indistinct; propodosomal plate 75 μ long, 105 μ wide, with anteromedian extension and indefinite margins, widest anterolaterally, with finely granulated pattern and no visible pores, 2 prs scapular setae on posterolateral margin of indefinite portion of plate—inner pair 22 μ long, outer pair 90 μ long; a small irregular plate on margin of propodosoma appears connected to anterolateral margin of propodosomal plate by apodeme; ventral apodemes of legs I-III extend to dorsum, appear as small dark plates on margin of propodosoma anterior to legs I-III; plate with irregular pattern overlying bases of legs II-III, that over III with 3 humeral setae; inner and outer seta subequal, half length of middle seta which is as long as leg III, outer seta lateral or lateroventral; hysterosomal plate rectangular, 137 μ long, 122 μ wide, with very irregular margins and granulated pattern, incompletely divided longitudinally, with shallow anterior cleft, deep posterior cleft; 2 prs fine setae, 1 pr oil gland pores and 1 pr other pores on outer margin—anterior pair setae 35μ long, posterior pair 58 μ long, 1 pr indistinct pores anteromedian, 1 pr distinct pores posteromedian; lateral submargin with groove, sometimes completely dividing plate in places; 2 prs posterior opisthosomal setae; anal groove posterior, extending slightly dorsally and ventrally; bursa copulatrix and canal as illustrated.

Venter: Apodemes of coxae I convergent most of length, unite near tip then diverge joining epigynium; apodeme of coxa II extending to tip of epigynium; apodemes of coxae III-IV joined by plate, enclosing coxa III; coxae I and III with a fine seta; epigynium crescent-shape, wide and narrow, tips 87 μ apart; genital lobes an inverse V with notch in outer posterolateral margin; 1 pr setae anterolateral, 1 pr opposite tip of genital lobes; 5 prs opisthosomal setae—1 pr median, 4

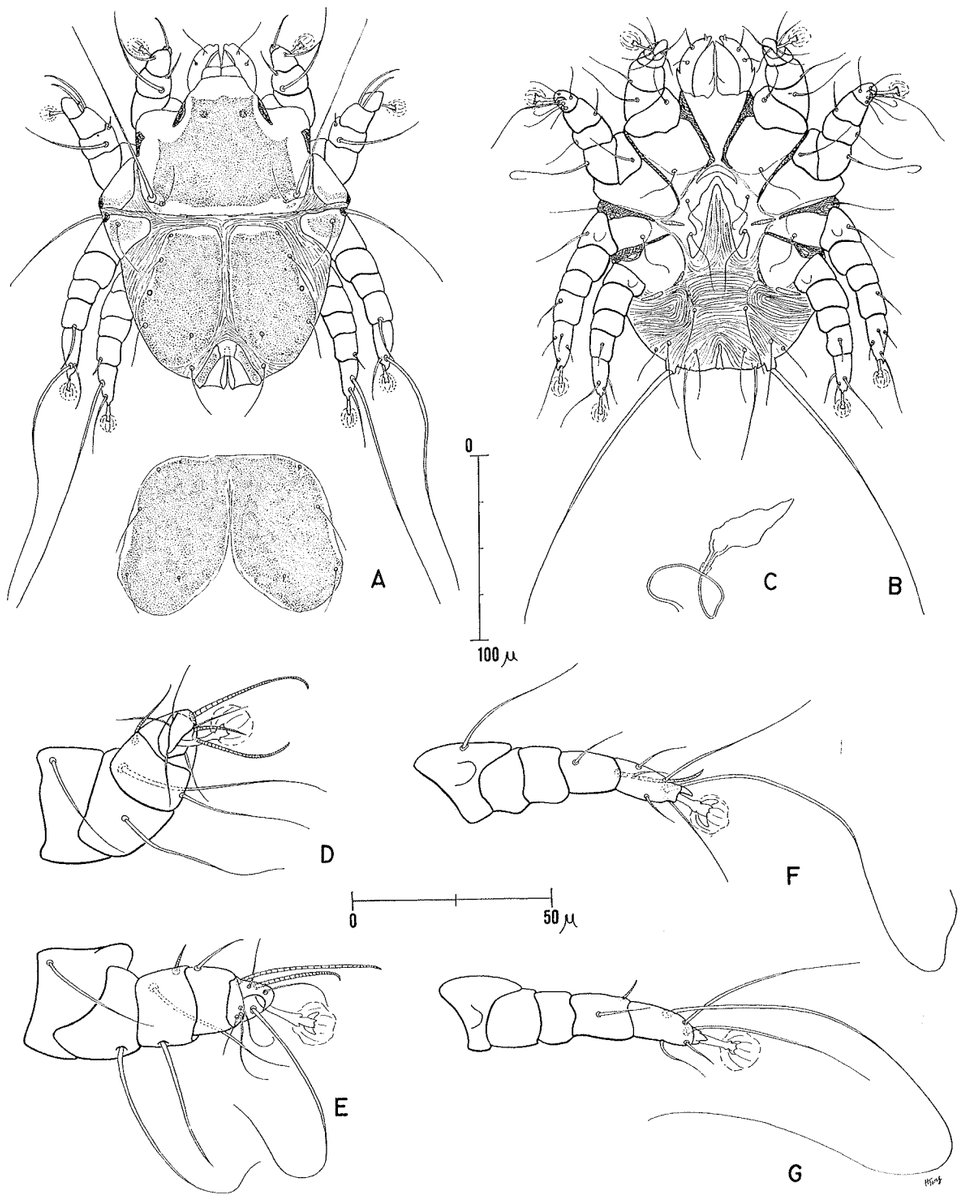

FIG. 1. *Microlichus avus* (Trouessart), nongravid ♀: A, dorsal view with variation in hysterosomal plates; B, ventral view; C, bursa copulatrix; D-G, legs I-IV, trochanter, femur, genu, tibia and tarsus, ventral view.

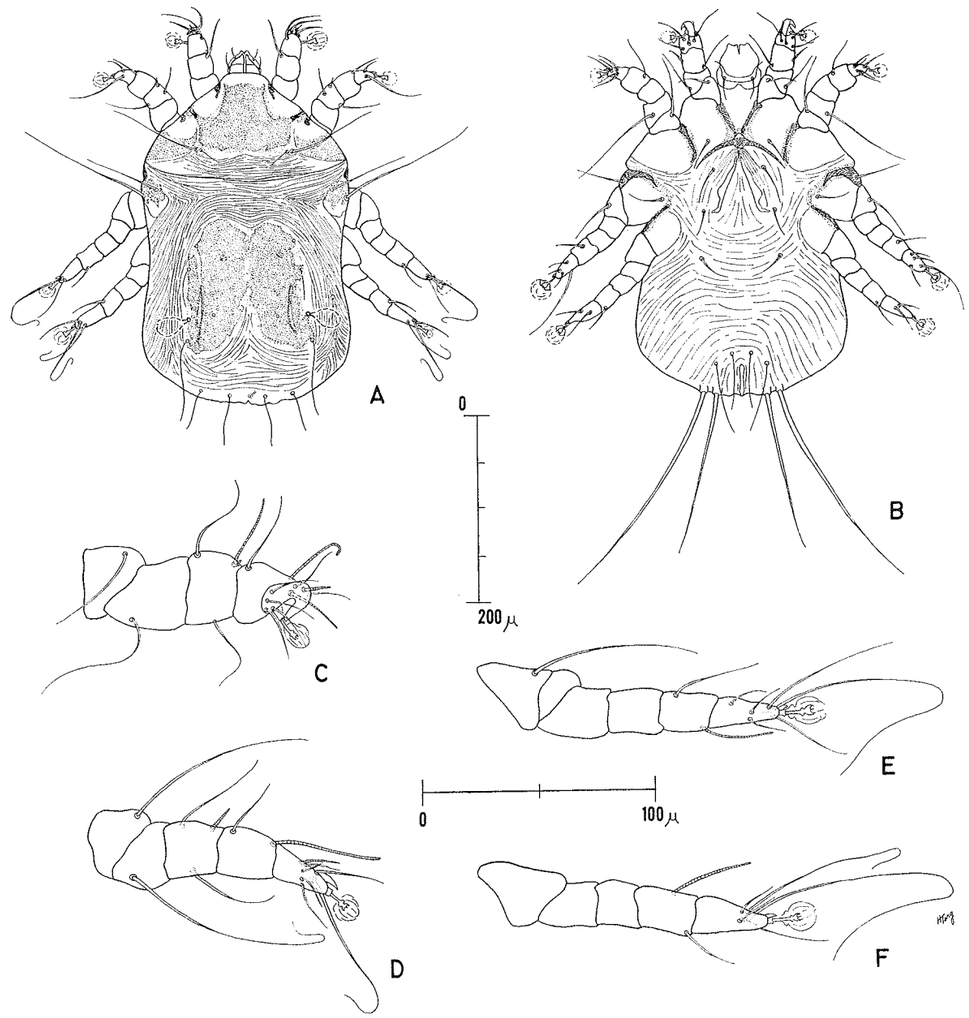

FIG. 2. *Microlichus uncus* Vitzthum, gravid ♀: A, dorsal view; B, ventral view; C-F, legs I-IV, trochanter, femur, genu, tibia and tarsus, ventral view.

prs surrounding anal groove, longest 274 μ, next longest 177 μ, both on tubercles on posterior body margin. *Gnathosoma*: Chelicera 52 μ long; palps with 2 prs of dorsal and ventral setae. *Legs*: I-II stouter and shorter than III-IV; tarsal claws stoutest on I, weakest on III-IV; tarsi with subglobular, entire caruncle on pedical about 1/3 total length; chaetotaxy as illustrated.

There was considerable variation in the degree to which the hysterosomal plate was longitudinally divided; however, in all cases the division was 50% or more of the total length of the plate with the greatest division on the posterior portion. In the only nongravid specimen available, the outer, posterior, dorsal ophisthosomal pair of setae is more ventral than dorsal.

This species is easily distinguished from *Mi. avus* by its larger size and incompletely divided hysterosomal plate. Also, apodemes of coxae I are united with each other and with the epigynium. Fain (1964) erected the genus *Promyialges* with *Mi. uncus* as the only species. We do not believe

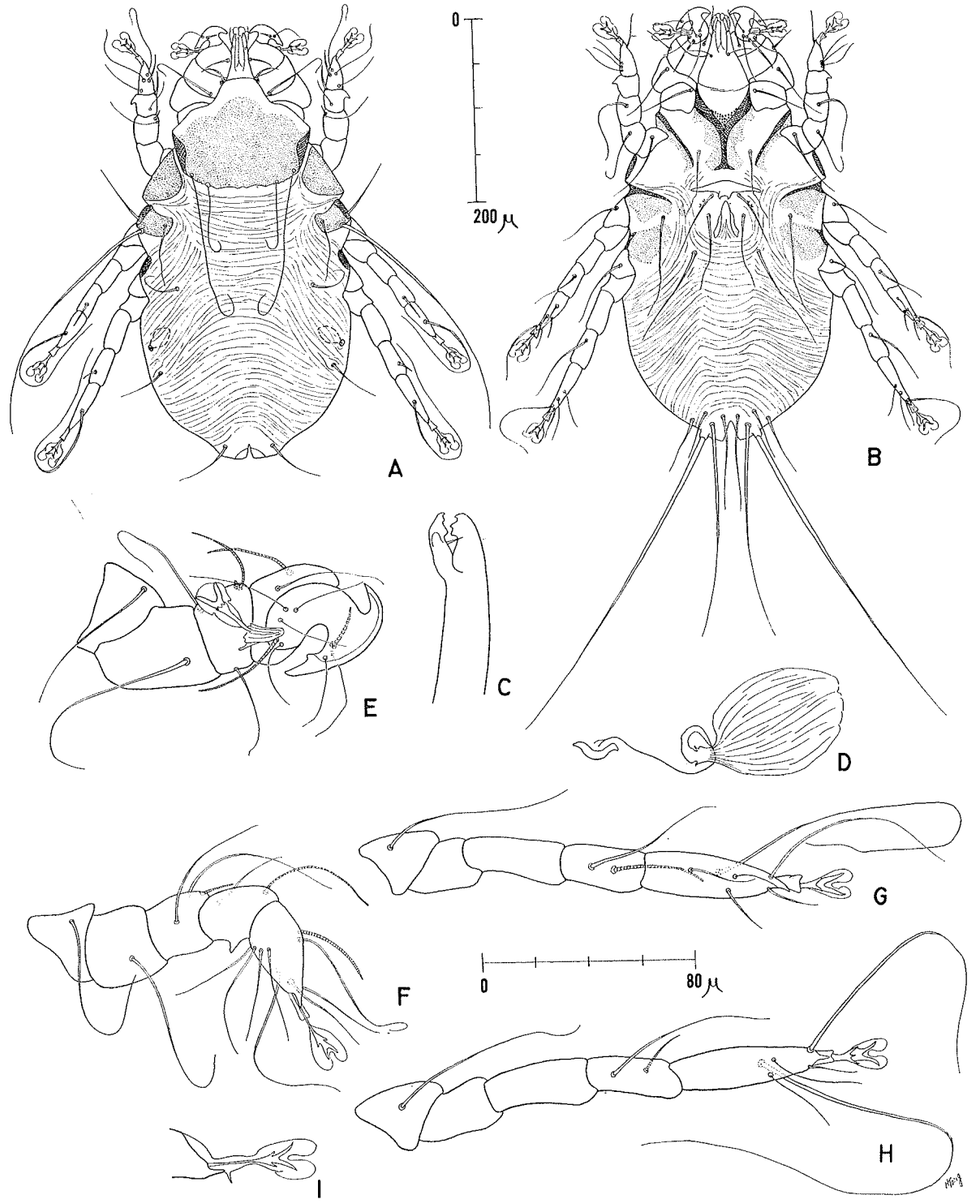

FIG. 3. *Myialges anchora* Sergent & Trouessart, nongravid ♀: A, dorsal view; B, ventral view; C, chelicera, ventral view; D, bursa copulatrix; E-H, legs I-IV, trochanter, femur, genu, tibia and tarsus, ventral view; I, tip of tarsus II, lateral view showing caruncle with spine-like development on pedicel.

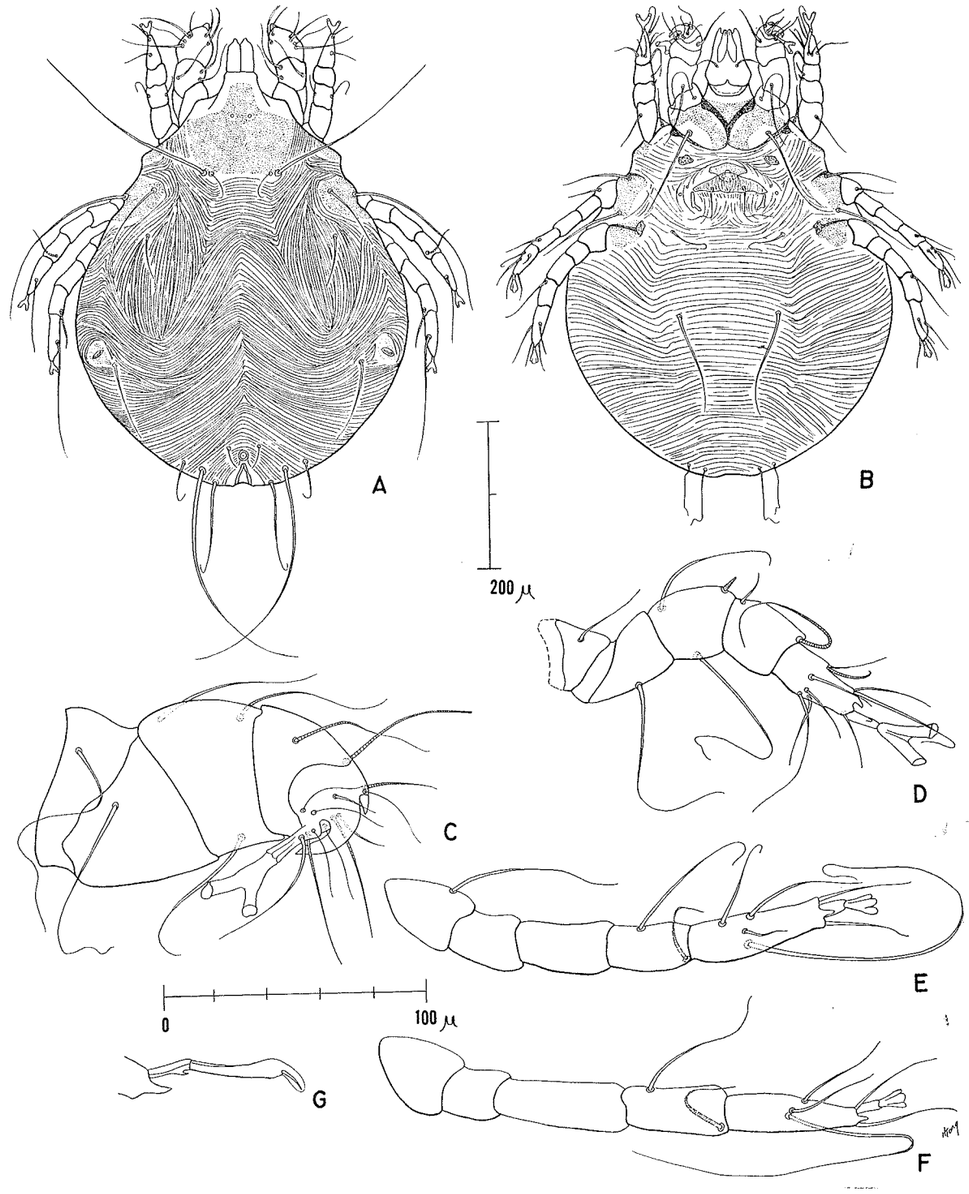

FIG. 4. *Myialges macdonaldi* Evans, Fain & Bafort, gravid ♀: A, dorsal view; B, ventral view; C-F, legs I-IV, trochanter, femur, genu, tibia and tarsus, ventral view; G, tip of tarsus II, lateral view showing caruncle with spine-like development on pedicel.

the characters he listed are of sufficient importance for separation from *Microlichus*.

Myialges anchora Sergent & Trouessart FIG. 3.

Myialges anchora Serg. & Troues., 1907, Compt. Rend. Soc. Biol. **62**(10):444.

♀. Measurements for idiosoma and posterior hypostomal setae for 1 and 4 specimens, respectively. *Body*: Nongravid specimen, length of idiosoma 357 μ; including gnathosoma, 428 μ; width, 244 μ. Gravid specimen, length of idiosoma, 653 μ; including gnathosoma, 724 μ; width, 259 μ; cuticle uniformly striated dorsally and ventrally except around anal groove. *Dorsum*: Line between propodosoma and hysterosoma absent; propodosomal plate 99 μ long, 154 μ wide, with slight anteromedian convexity, posterior margin sinuous, widest at midlateral margin, no visible pores; 2 prs scapular setae on posterolateral margin—inner pair 58 μ long, outer pair 143 μ long; plate overlying bases of legs II-III, that over III with 3 humeral setae; inner and outer seta subequal, less than 1/3 as long as middle seta which extends past tip of leg III; 3 prs slender opisthosomal setae—1 pr opposite leg IV, 1 pr 28 μ long, behind oil gland pores, 1 pr flanking anal groove; oil gland pores midlateral without surrounding plates; anal groove posterior, extending slightly dorsally and ventrally; bursa copulatrix and canal as illustrated. *Venter*: Apodemes of coxae I converge, uniting about midway, then diverging slightly at tip; different textured sclerotizations as illustrated surround apodemes of coxae I; apodemes of coxae II-IV not as well developed or joined; coxae I and III with a long fine seta; epigynium obtusely triangular in shape, at level between apodemes of legs II and III; genital lobes an inverse V, flanked by 2 prs setae and 1 or 2 prs pores; 6 prs opisthosomal setae—1 pr opposite coxae IV, 5 prs surrounding anal groove with longest, 378 μ, next, 241 μ, others much shorter. *Gnathosoma*: Chelicera 52 μ long; palps with 1 pr fine seta dorsally, 2 prs ventrally. *Legs*: I stoutest, short, ventrally with large tarsal claw and Y-shaped caruncle; II slightly stouter than III-IV; all with small tarsal claw and Y-shaped caruncle on pedicel about 1/3 total length of caruncle; tibia II with lateral spur-like projection; in lateral view pedicel of tarsus I-II with spine-like development; chaetotaxy as illustrated.

The ventral opisthosomal setae shift posterolaterally or slightly dorsally in gravid specimens.

Myialges macdonaldi Evans, Fain & Bafort FIG. 4.

Myialges macdonaldi Evans, Fain & Baf., 1963, Bull. Ann. Soc. Roy. Ent. Belg. **99**(34):489.

♀. Length and width of nongravid mites based on 3 specimens. *Body*: Nongravid specimens, length of idiosoma 334 μ; including gnathosoma, 403 μ; width, 240 μ. Gravid specimens, length of idiosoma, 502 μ; including gnathosoma, 566 μ; width, 392 μ; cuticle uniformly striated dorsally and ventrally, striations close together. *Dorsum*: Line between propodosoma and hystrosoma absent; propodosomal plate 108 μ long, 149 μ wide, with anteromedian extension, widest anterolaterally, 1 pr pores located anteromedially, 2 prs scapular setae bordering posterolateral margin—inner pair 36 μ long, usually on margin of propodosomal plate, outer pair 190 μ long, adjacent to propodosomal plate, at times weakly connected to it; plate overlying bases of legs II-III, that over III with 3 humeral setae; inner and outer seta subequal, less than half as long as middle seta which extends slightly past tip of leg III; 6 prs slender opisthosomal setae—1 pr posterior to humeral plates, 1 pr 11 μ long, posteromedian to oil glands, 4 prs surrounding anal groove with longest 428 μ, next, 168 μ, others much shorter; oil glands midlateral, surrounded by plate which frequently connects adjacent setae by narrow extension; anal groove posterior, extending slightly dorsally and ventrally; bursa copulatrix circular, anterior to anal groove and between pair of setae. *Venter*: Apodemes of coxae I-II fused, enclosing coxa I; apodemes of coxae I converge, contiguous about 40% of length; apodemes of coxae III-IV not as well developed or joined; coxae I and III with a long fine seta; epigyniumt rapezoidal shape; genital lobes poorly developed; 1 pr setae anterior; 2 prs pores flanking genital groove; 4 prs slender opisthosomal setae—1 pr opposite coxae IV, 1 pr about center of opisthosoma, 2 prs on posterior margin. *Gnathosoma*: Chelicera 96 μ long; palps with 1 pr fine setae dorsally and ventrally. *Legs*: Increase in length and size from I to IV. I short, stout, ventrally with large tarsal claw and smaller spine; long Y-shaped caruncle lies under tarsal claw; II-IV with small tarsal claw and long Y-shaped caruncle on pedicel about 1/3 total length of caruncle; in lateral view pedicel with spine-like development; chaetotaxy as illustrated.

In gravid specimens the outer humeral setae and posterior dorsal opisthosomal setae shift lateral or ventral. The Y-shaped caruncle of tarsus I and spine-like development on the pedicel of caruncles II-IV is often difficult to see.

My. macdonaldi is easily distinguished in the female from *My. anchora* by the shape of the claw on tarsus I, absence of lateral spur-like projection on tibia II and shape of the propodosomal plate.

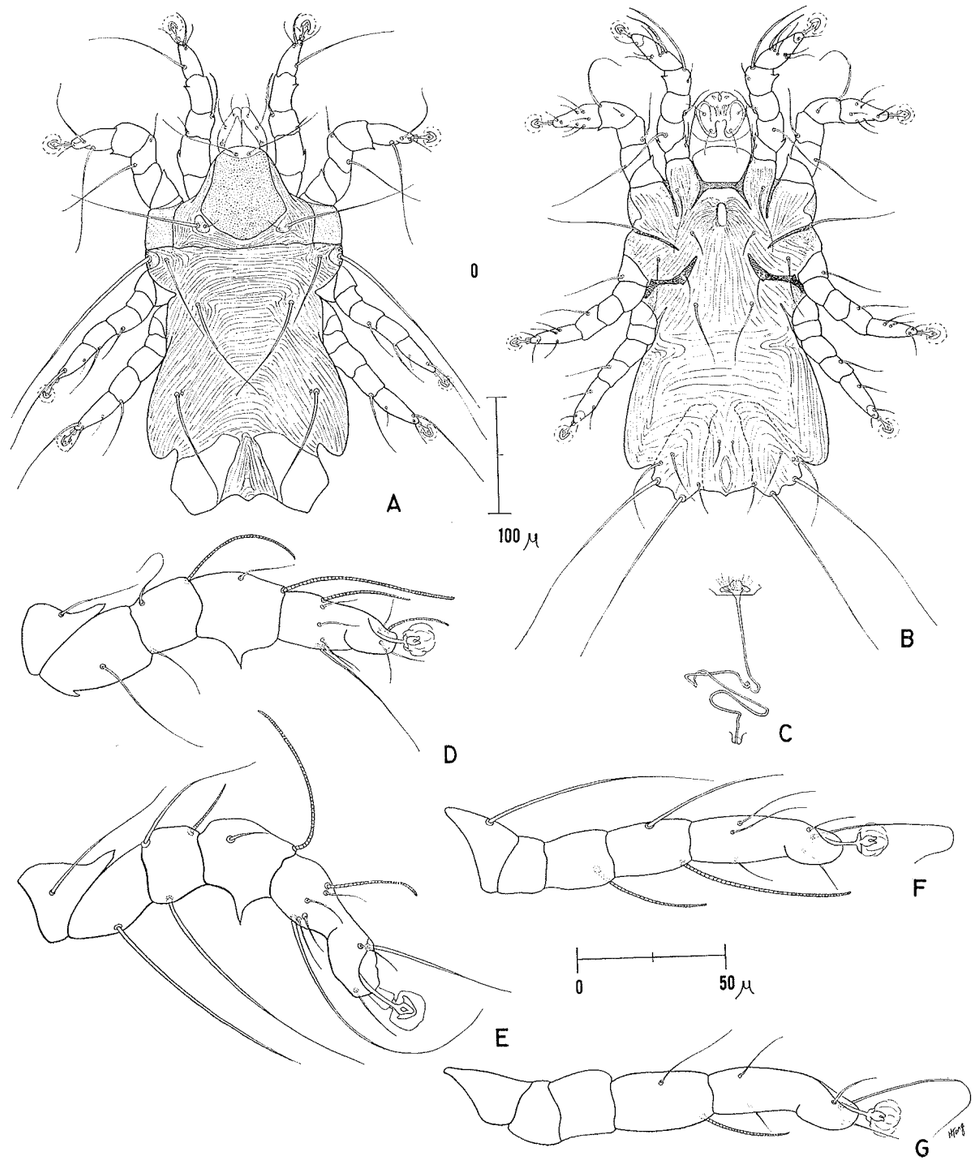

FIG. 5. *Strelkoviacarus critesi* Spory, nongravid ♀: A, dorsal view; B, ventral view; C, bursa copulatrix; D-G legs I-IV, trochanter, femur, genu, tibia and tarsus, ventral view.

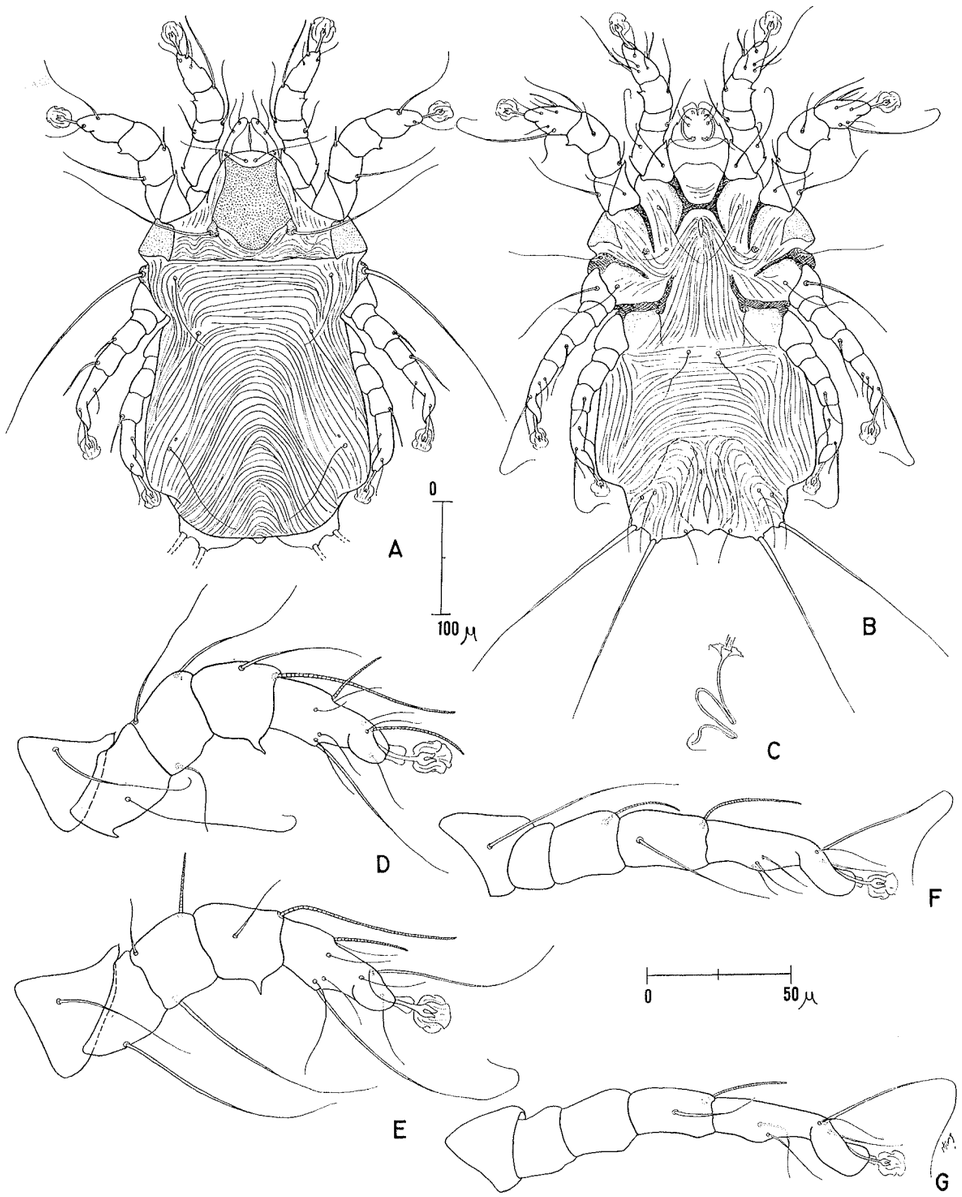

FIG. 6. *Strelkoviacarus quadratus* (Haller), nongravid♀: A, dorsal view; B, ventral view; C, bursa copulatrix; D-G, legs I-IV, trochanter, femur, genu, tibia and tarsus, ventral view.

Strelkoviacarus critesi Spory FIG. 5, 7.
Strelkoviacarus critesi Spory, 1965, Ohio J. Sci. **65**(2):50.

♀. *Body*: Nongravid specimens, length of idiosoma 348 μ; including gnathosoma, 372 μ; width 200 μ; cuticle uniformly striated dorsally, less distinctly striated ventrally. *Dorsum*: Line between propodosoma and hysterosoma distinct; propodosomal plate 81 μ long, 71 μ wide, broadly rounded anteriorly, strongly convex posteriorly, widest at posterolateral margin, with 1 pr long thin vertical setae on anterior unpunctate portion of plate; 2 prs scapular setae on pair of small plates bordering posterolateral margin of propodosomal plate—inner pair 12 μ long, outer pair 127 μ long, plates at times weakly connected to propodosomal plate; plates overlying bases of legs II-III, that over II, large, extending laterally and slightly ventrally, that over III, small, bearing 2 humeral setae—inner seta extending past tip of leg III, outer seta about half length of inner seta and lateral or lateroventral; 3 prs long hysterosomal setae—1st and 2nd extending past bases of 2nd and 3rd, respectively, 3rd extending to posterior margin of opisthosoma, 1st opposite humeral setae, 2nd opposite leg IV 3rd on opisthosoma with pair of small pores usually less than 2 μ anteromedian to base; opisthosomal plates paired, approximately wedge-shape, bordering posterior body margin; bursa copulatrix between opisthosomal plates, with long sinuous canal.

Venter: Apodomes of coxae I converge some 60% of their length where they are united by crosspiece, then diverge; apodemes of coxae II-IV free, that of coxae IV extending inward and upward with seta at angle; genital groove at level of coxae II, bordered by apodemes and crosspiece of coxae I; coxae I and III with a long fine seta; 2 prs of podosomal setae—1 pr posterolateral to genital aperture, 1 pr opposite leg IV; 6 prs opisthosomal setae surrounding anal groove and on posterior margin—2 prs on posterior margin, long, stout, slightly subequal, inner pair 212 μ long, outer pair 227 μ long; 1 pr posterior internal plates, faintly distinguishable, shape similar to dorsal opisthosomal plates. *Gnathosoma*: Palps dorsally with 2 prs long fine setae, 1 pr short basal spine-like setae, ventrally with 2 prs long fine setae, 1 pr short spine-like setae midlaterally. *Legs*: I-II slightly stouter than III-IV; all tarsi lacking claws but with globular caruncles on pedicle which originates postapically; trochanters I-II with internal spur-like distal extension of segment; femur I with basal external notch; tibiae I-II with external spine-like extension; dorsally

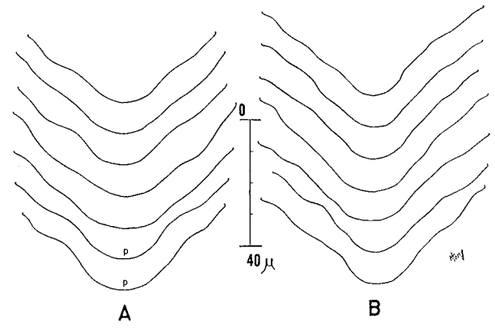

FIG. 7. Female posterior margin of propodosomal plate. A, *Strelkoviacarus critesi* (p=paratypes); B, *Strelkoviacarus quadratus*.

femur and genu of legs I-II with pattern similar to propodosomal plate; chaetotaxy as illustrated.

Strelkoviacarus quadratus (Haller) FIG. 6, 7.
Pteronyssus quadratus Haller, 1882, Archiv. Naturgesch **48**(1):69.

♀. *Body*: Nongravid specimens- length of idiosoma 348 μ; including gnathosoma, 404 μ; width 206 μ; cuticle uniformly striated dorsally and ventrally. *Dorsum*: Line between propodosoma and hysterosoma distinct, propodosomal plate 91 μ long, 78 μ wide, broadly rounded anteriorly, strongly convex posteriorly, widest at posterolateral margin, with 1 pr long thin vertical setae on anterior unpunctate portion of plate; 2 prs scapular setae on pair of small plates bordering posterolateral margin of propodosomal plate, inner pair 12 μ long, outer pair 135 μ long; plates weakly connected to propodosomal plate; plates overlying bases of leg II-III, that over II large, extending laterally and ventrally, that over III small, bearing 2 humeral setae—inner seta slightly longer than leg III, outer seta about half length of inner seta and lateral or lateroventral; 3 prs long hysterosoma setae—1st pr opposite humeral setae and extending past base of 2nd pr, 2nd pr opposite leg IV extending almost to base of 3rd pr, 3rd pr on opisthosoma extending to or slightly beyond posterior margin with pair of small pores 5 μ anteromedian to base; opisthosomal plates absent; bursa copulatrix with long sinuous canal.

Venter: Apodomes of coxae I convergent more than half their length, then united by crosspiece, then diverge; apodemes of coxae II-IV free, that of coxa IV extending inward and upward, with seta at angle; genital groove at level of coxae II bordered by apodemes and crosspiece of coxae I; coxae I and III with long fine seta; 2 prs podosomal setae —1 pr posterolateral to genital groove, 1 pr op-

posite leg IV; 6 prs opisthosomal setae surrounding anal groove and on posterior margin—2 prs on posterior margin long, stout, subequal, inner pair 169 μ long, outer pair 202 μ long; 1 pr posterior internal plates easily distinguishable in ventral view. *Gnathosoma*: Palps dorsally with 2 prs long fine setae, 1 pr short basal spine-like setae, ventrally with 2 prs long fine setae, 1 pr short spine-like setae midlaterally.

Legs: I-II slightly stouter than III-IV; all tarsi without claws but with globular caruncles on pedicle which originates postapically; trochanters I-II with internal spur-like distal extension of segment; femur I with basal external notch; tibiae I-II with external spine-like extension; dorsally all segments except coxa and tarsus of all legs have pattern similar to propodosomal plate; chaetotaxy as illustrated.

The dorsal pattern on trochanters I-II and legs III-IV is not easily seen. *S. quadratus* is very close to *S. critesi* from which it may be immediately separated by the absence of dorsal opisthosomal plates. Other less obvious differences are the posterior shape of the propodosomal plate, and greater distance between the pores and base of the 3rd pair of opisthosomal setae. In *S. quadratus* the posteromedian convexity of the propodosomal plate is slightly more acutely rounded than in *S. critesi* (FIG. 7).

Key to Common Species of Mites on Hippoboscidae in British Isles

Females

1. Propodosomal plate with anteromedian extension, usually wider than long.....2
   Propodosomal plate without anteromedian extension, longer than wide..... .....(**Strelkoviacarus**).....3
2. With dorsal opisthosomal plate .... (**Microlichus**).....4
   Without such plate .....(**Myialges**).....5
3. With paired, posterior, dorsal opisthosomal plates .....**Strelkoviacarus critesi**
   Without such plates .... **Strelkoviacarus quadratus**
4. Dorsal opisthosomal plate paired (or only slightly united), apodemes of coxae I free ..... **Microlichus avus**
   Dorsal opisthosomal plate entire but strongly incised antero- and posteromedially, apodemes of coxae I united..... ..... **Microlichus uncus**
5. Tibia II with posterior spur-like projection, claw on tarsus I strongly developed anteriorly and posteriorly.....**Myialges anchora**
   Tibia II without such projection, claw on tarsus I strongly developed anteriorly only ..... **Myialges macdonaldi**

Gibraltar Point

The total number of each mite collected at Gibraltar Point is given in TABLE 2. *S. critesi* and *My. macdonaldi* were far more abundant than any of the others, although *Mi. avus* and *Tyrophagus* sp. were regularly encountered.

TABLE. 2. Number of mites collected from *Ornithomya* at Gibraltar Point, 1957–59.

	S. critesi	*My. macdonaldi*	*Mi. avus*	*Tyrophagus* sp.	Others
No. collected 1957	25	40	25	3	1
No. collected 1958	217	59	9	5	1
No. collected 1959	178	177	7	2	1
Total	420	276	41	10	3
No. infested flies	87	71	9	9	3
Mean/infested fly	4.8	3.9	4.6	1.1	1
Range	1—38	1—13	1—25	1— 2	1

Overall mean infestation = 4.6 mites per infested fly, range 1–43

Fly hosts: Three species of *Ornithomya* were found, but *O. fringillina* was by far the most common and most frequently and heavily infested with mites (TABLE 3). The number of *O. chloropus* caught was too low to yield reliable results, and too few *O. avicularia* were collected to permit accurate comparison with *O. fringillina*. However, infestation figures for *O. fringillina* (25.9%) and *O. avicularia* (1.8%) indicate a probable difference in degree of infestation.

TABLE 5 shows that *My. macdonaldi* was found on *O. avicularia* only three times, and these infestations were well above the average of 4 mites per infested fly, numbering 10, 13 and 10 mites, respectively. There was also a difference between the degree of infestation of male and female *O. fringillina*; 21.1% of the males were infested compared to 31.5% of the females. The sex ratio of the fly population sampled throughout the two seasons was 53% ♂♂ to 47% ♀♀ (Hill 1963). In part, this difference in infestation results from phenological differences of the sexes—male flies are more abundant during the first part of the season and females during the latter part (Hill 1963). Comparison of FIGS. 1 and 2 from Hill (1963) with FIG. 8 shows that the mite population was much larger during the latter part of the season when female flies predominated. Whether or not there was actual preference by the mites for females was not revealed in this study.

TABLE 3. Proportion of *Ornithomya* infested with *My. macdonaldi* and *S. critesi* at Gibraltar Point, 1958–59.

Species	Sex	1958 Flies Examined	1958 Flies Infested *My. macdonaldi*	1958 Flies Infested *S. critesi*	1959 Flies Examined	1959 Flies Infested *My. macdonaldi*	1959 Flies Infested *S. critesi*	Total Flies Examined	Total Flies Infested *My. macdonaldi*	Total Flies Infested *S. critesi*	Percent Flies Infested *My. macdonaldi*	Percent Flies Infested *S. critesi*
O. fringillina	♂	116	5	14	159	17	22	275	22	36	8.0	13.1
	♀	91	8	22	150	26	20	241	34	42	14.1	17.4
	Total	207	13	36	309	43	42	516	56	78	10.8	15.1
O. chloropus	♂	0	0	0	3	0	0	3	0	0	—	—
	♀	1	0	0	8	0	1	9	0	1	—	11.1
	Total	1	0	0	11	0	1	12	0	1	—	8.3
O. avicularia	♂	8	0	0	11	0	0	19	0	0	—	—
	♀	26	1	0	9	0	0	35	1	0	2.8	—
	Total	34	1	0	20	0	0	54	1	0	1.8	—

TABLE 4. Location on flies of four species of mites at Gibraltar Point, 1957–59.

Location	% mites per location *Mi. avus*	*My. macdonaldi*	*S. critesi*	*Tyrophagus* sp.
Under head			14.1	
Neck			3.5	
Top of thorax			1.3	
Sides of thorax	5		5.3	
Under thorax			13.2	70
Abdomen		100	1.3	30
Wings	95		1.3	
Femora			59.6	
Tibiae			0.4	
Total mites collected	41	276	420	10

TABLE 5. Hosts of flies infested with mites at Gibraltar Point, 1956–59.

Host	Age*	*S. critesi*	*Mi. avus*	*My. macdonaldi*	*Tyrophagus* sp.	*Others*
Long-eared owl (*Asio otus* (L.))	A	1f**		1a, 1f		
Cuckoo (*Cuculus canorus* L.)	J			1a		
Song thrush (*Turdus ericetorum* Turton)	J			1a		
Lesser whitethroat (*Sylvia curruca* (L.))	A			1f		
Whitethroat (*Sylvia communis* Lath.)	A	1f				
Whitethroat	J	76f	9f	35f	7f	2f
Dunnock (*Prunella modularis* (L.))	J	5f		16f	1f	
Blue tit (*Parus caeruleus* L.)	A			1f		
Great tit (*Parus major* L.)	J			1f		
Meadow pipit (*Anthus pratensis* (L.))	J			1f		
Reed bunting (*Emberiza schoeniclus* (L.))	W			1f	1f	1f
Yellow bunting (*Emberiza citrinella* L.)	A	1c				
Yellow bunting	J			1f		

*A = Adult, J = Juvenile, W = 1st Winter
**a = *Ornithomya avicularia*, c = *O. chloropus*, f = *O. fringillina*

Of 179 infested flies, 78% carried 1 species of mite, 18% 2 species and 3% 3 species. There was no evidence that the presence of 1 species of mite on a fly in any way influenced the infestation of that fly by other species of mites.

In 24 cases of birds carrying 2 flies, there were 12 cases where only 1 fly carried mites and 12 where both flies were infested. Of 17 cases with 3–8 flies per bird, there were 6 cases with all flies infested. In 1958–59 there were 63 cases of multiple infestations of birds by flies free of mites (35 of 2 flies, 28 of 3–8 flies per bird). The larger infestations of mites (*S. critesi*, 18–38 mites per fly; *My. macdonaldi*, 7–13; *Mi. avus* 4–25) were on flies comprising single infestations.

TABLE 4 shows the different mite species infest-

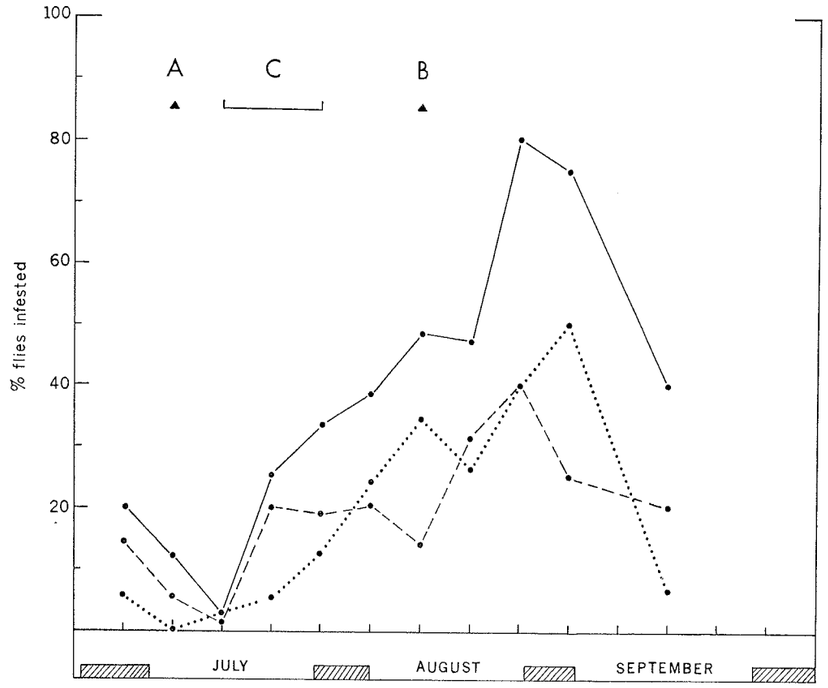

FIG. 8. Seasonal occurrence of mites on *O. fringillina* at Gibraltar Point, 1958–59. The season is divided into weekly periods starting when the first birds infested with flies were caught. The two seasons were more than a week out of phase (cross-hatch below graph). Dotted line=occurrence of *My. macdonaldi*. Broken line=occurrence of *S. critesi*. Solid line=total mite load of preceding species and *Mi. avus* on flies. A-B=period of fly emergence. C=peak of fly population.

ing different parts of the fly's body. *My. macdonaldi* was confined entirely to the abdomen; *Mi. avus* was found mostly under wings at the base and in a few cases on the side of the thorax. *S. critesi* was restricted largely to the femora and under head and thorax. *Mi. avus* and *S. critesi* were attached loosely to the host; *S. critesi* could be dislodged from flies by slightest pressure and several times were observed walking on the thorax.

Distribution of *Mi. avus* and *S. critesi* appears related to its cleaning habits. The mites are located in areas not affected by the fly's cleaning movements, as underside of thorax and head and under wing at base. *My. macdonaldi* was found only on lateral and posterior margins of the abdomen. Presumably, here the mite is affected little by cleaning movements or movements through the feathers. When more than 1 mite of this species was found on a fly, they were distributed equally on each side of the abdomen. *My. macdonaldi* was always firmly attached to the fly by the first pair of legs and mouthparts which were embedded in the soft abdominal integument. If forcibly removed the mite left a small dark brown crescentic scar. On two occasions old scars were observed on the fly's abdomen. This suggests that normally mites remain at their first attachment site during their infestation.

Of 276 *My. macdonaldi* collected, 234 were surrounded by individual egg masses (FIG. 9A, 9B), 41 had no eggs and 1 egg mass was without a mite. In multiple infestations by this species it was found, with two exceptions, that either all mites had egg masses or none had. This suggests that all mites reached a fly at the same time and were about the same age. Eggs were not laid until mites had been on the flies for some time, it seemed, as most mites without eggs were found very early in the season. Sizes of egg masses did not alter much with the season except for two cases where early infestations had smaller than usual egg masses.

Bird hosts: It is very likely that mites regularly found on *Ornithomya* are primarily skin or feather parasites of birds. TABLE 5 lists birds from which mite-infested flies were collected (bird names from

Witherby et al. 1958). The local population of *O. fringillina* was supported almost entirely by young, locally bred whitethroats and dunnocks (Hill 1962); correspondingly, these birds comprised a large proportion of the hosts. Hill (1962) has shown that at Gibraltar Point in 1958–59 young whitethroats were significantly more heavily infested by *O. fringillina* (210 of 632) than were young dunnocks (44 of 220). However, the proportion of mite-infested *O. fringillina* taken from young whitethroats was considerably smaller (73 of 210) than that taken from dunnocks (23 of 44). The 22 mite-infested flies from dunnocks constituted 16 infestations by *My. macdonaldi*, 5 by *S. critesi* and 1 mixed infestation of these species. Since the total number of flies infested by these mites is 61 and 84, respectively, it would seem that *My. macdonaldi* showed preference for dunnocks rather than whitethroats. Conversely, it also indicates a higher proportion of flies from whitethroats with *S. critesi* (76 of 111) than with *My. macdonaldi* (35 of 111). *Mi. avus* was collected only from *O. fringillina* from whitethroats. There was no significant difference between extent of infestations of *S. critesi* and *My. macdonaldi* on *O. fringillina* from either whitethroats or dunnocks.

The seasonal distribution of *O. fringillina* infested by *S. critesi* and *My. macdonaldi* is illustrated by FIG. 8 and TABLE 6. The sharp drop in infestation during the third week resulted from simultaneous fledging of a large number of uninfested whitethroats in 1959. During the first five weeks of the season, infestations were mainly by *S. critesi*, whereas during the second five weeks they were predominantly by *My. macdonaldi*. During the final four weeks, both species were more or less equally represented on the flies, but only very small numbers of flies were collected during this time. The period of maximum infestation of flies by mites was well after the fly population peak FIG. 8. Insufficient *Mi. avus* were collected to permit investigation of their seasonal distribution.

FAIR ISLE

The situation at Fair Isle was simpler than at Gibraltar Point. During most of the season when flies were active, only *O. chloropus* was present, and the five species of breeding birds involved were the only passerine species that occurred commonly in the trapping area. Therefore, it can be assumed that those mites that occurred commonly on the flies came from one or more of these five avian hosts and not from other species. Sufficient non-passe-

TABLE 6. Seasonal occurrence of *My. macdonaldi* and *S. critesi* on *O. fringillina* at Gibraltar Point, 1958–59.

	1958			1959			Total			Percent	
	Flies Examined	Flies Infested		Flies Examined	Flies Infested		Flies Examined	Flies Infested		Flies Infested	
Week		*My. macdonaldi*	*S. critesi*		*My. macdonaldi*	*S. critesi*		*My. macdonaldi*	*S. critesi*	*My. macdonaldi*	*S. critesi*
1	20	1	2	15	1	3	35	2	5	5.7	14.3
2	50	0	2	36	0	3	86	0	5	—	5.8
3	14	1	1	57	1	0	71	2	1	2.8	1.4
4	23	2	2	52	2	13	75	4	15	5.3	20.0
5	41	2	12	68	12	9	109	14	21	12.8	19.2
6	33	6	8	29	9	5	62	15	13	24.2	20.9
7	10	1	0	25	11	5	35	12	5	34.3	14.3
8	6	2	3	13	3	3	19	5	6	26.3	31.5
9	2	0	2	3	2	0	5	2	2	40.0	40.0
10	—	—	—	4	2	1	4	2	1	50.0	25.0
11	—	—	—	5	1	0	5	1	0		
12	2	0	0	0	0	0	2	0	0	6.7	20.0
13	6	0	2	1	0	0	7	0	2		
14	0	0	0	1	0	1	1	0	1		
Total:	207	15	34	309	44	43	516	59	77	11.4%	14.9%

In 1958 the season started 30 June and ended 4 October.
In 1959 the season started 18 June and ended 30 September.

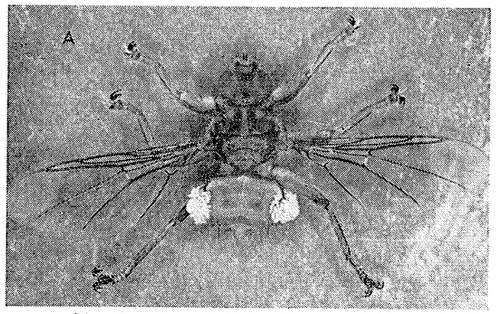

FIG. 9A. Dorsal view ♂ *O. fringillina* with 2 *My. macdonaldi* ♀♀ and egg masses attached to abdomen sides. (Photographs by D.S. Hill)

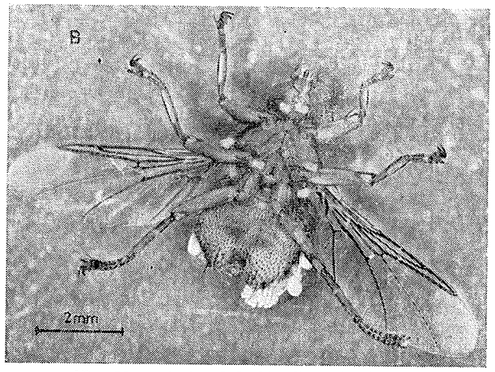

FIG. 9B. Ventral view ♀ *O. fringillina* with 8 *S. critesi* ♀♀ on legs, thorax, and underside of head; 4 *My. macdonaldi* ♀♀ and egg masses on abdomen.

rine birds were examined to show that none was an important host of the flies. The birds examined were predominantly juveniles. The wheatear is single-brooded on Fair Isle while the other species are predominantly double-brooded. Migrant birds, occasionally carrying other species of flies, occurred mostly before and after the period of activity of the local flies and few were infested.

The most relevant features of the life history and ecology of *O. chloropus* can be summarized from Corbet (1956): 1) There is one generation a year, the emergence being in late June after which they decrease in numbers until scarce by late August. 2) Released flies showed no host specificity among the birds studied. 3) Marking individual flies showed that after a mean recapture period of 5.5 days, 23 of 92 had changed hosts, 17 to the same species and 6 to a different species of bird.

Four species of mites were recognized during the course of the work. Three of these occurred commonly on flies and were considered regular mites of bird flies. The fourth species belonged to the family Proctophyllodidae which previously has not been associated with hippoboscid flies. A discussion of each species follows.

Microlichus avus. This was the dominant species of mite on flies from starlings (TABLE 7). They occurred in the grooves of the thorax, at the bases of the wings and, especially in heavy infestations, in clusters on the anterolateral corners of the abdomen. Largest number counted was 230; many individuals had over 100 and about 400 were estimated on one fly. In 1955 the mean number of *Mi. avus* per infested fly fell from 17 in late June (n=66) to 5 in late July (n=8). Only females were found but they were never accompanied by eggs. Seasonal incidence on flies from juvenile starlings in 1954 is shown in FIG. 10. The 1955 pattern for flies from the first brood birds was virutally identical; but the proportion of infested flies from the second brood fell from 93% to 42% during the first half of August, compared with an increase of the same magnitude

TABLE 7. Degree of infestation by three species of mites on *O. chloropus* from five avian hosts, Fair Isle, 1954–55.

Host	Year	Flies Examined	Flies Infested (%)		
			Mi. avus	*Mi. uncus*	*S. quadratus*
Starling	1954	159	50 (31%)	3 (2%)	1 (1%)
(*Sturnus vulgaris* L.)	1955	274	161 (59%)	2 (1%)	3 (1%)
Wheatear	1954	251	12 (5%)	3 (1%)	169 (67%)
(*Oenanthe oenanthe* (L.))	1955	137	9 (7%)	2 (1%)	72 (53%)
Rock pipit	1954	225	18 (8%)	13 (6%)*	13 (6%)
(*Anthus spinoletta* (L.))	1955	151	19 (13%)	16 (11%)	14 (9%)
Meadow pipit	1954	58	2 (3%)	4 (7%)	2 (3%)
(*Anthus pratensis* (L.))	1955	49	1 (2%)	3 (6%)	0
Twite	1954	23	1 (4%)	3 (13%)	3 (13%)
(*Carduelis flavirostris* (L.))	1955	8	1 (13%)	1 (13%)	1 (13%)

*A minimum figure, excluding several cases of doubtful identity.

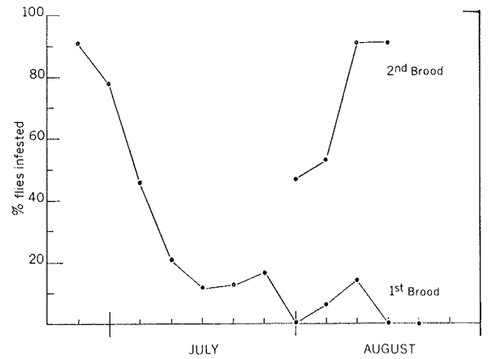

FIG. 10. Seasonal occurrence of *O. chloropus* infested with *Mi. avus* on juvenile starlings at Fair Isle, 1954.

in 1954. We can conclude, however, that flies on newly emerged fledglings of both broods are heavily infested and mites either leave the flies quickly or the infestation on the birds falls very rapidly leaving little chance for recently arrived flies to acquire mites.

Only three recoveries of marked flies involved *Mi. avus*, all having been collected originally from starlings. One with 15 mites was released on a meadow pipit and recovered on the same bird the following day still with 15 mites. One with 13 *Mi. avus* and 7 *S. quadratus* was liberated without a host and recovered four days later on a rock pipit with only 1 *Mi. avus*. Another with 7 *Mi. avus* was liberated without a host and recaptured the following day on a snipe (*Capella gallinago* (L.)), still with 7 *Mi. avus*.

Two records of *Mi. avus* were obtained from flies on migrants. A common sandpiper (*Tringa hypoleucos* L.) captured on 10.IX.1956 had a single fly with 30 *Mi. avus*; a merlin (*Falco columbarius* L.) taken on 18.VIII.1954 had one of four flies infested with 20 *Mi. avus*. This latter fly also carried six lice, *Sturnidoecus sturni* (Schrank), indicating it had been derived from a starling.

Microlichus uncus. It is highly probable that this species was acquired by flies from both species of pipits and there was one proven case of the acquisition of mites by a marked fly on a rock pipit. The number of infested flies from twites (4 of 31) is too small to judge whether this bird is a regular host of *Mi. uncus* (TABLE 7). The maximum number of mites on a fly was 20, far fewer than in the case of *Mi. avus*. They were found almost entirely under the bases of the wings firmly attached to veins. Enough flies were examined only from rock pipits to indicate the seasonal pattern of incidence. The 1955 proportion of flies infested fluctuated between 7% and 14% between late July and September. The mean number of mites per fly examined was about 0.5 during late July and August rising to the 1.6 in September. This is quite different from the pattern of *Mi. avus* on the starling.

Eggs were commonly present, attached to the under surface of the wings. No larvae were detected on the flies, but one of many attempts to incubate eggs on detached wings resulted in the hatching of two larvae. The proportion of empty shells on the wings increased throughout the season. TABLE 8 summarizes the relevant data from all flies carrying *Mi. uncus* irrespective of the avian host.

TABLE 8. Analysis of infestation of *Mi. uncus* on *O. chloropus* on Fair Isle, 1955.

	Late July	Early August	Late August	Early September
No. of flies with mites and/or eggs	10	7	3	3
No. with eggs or shells only	0	2	0	1
No. with empty shells	4	3	3	3
No. of mites	63	26	25	7
No. of unhatched eggs	45	116	216	67
Ratio of unhatched eggs: mite	0.7 : 1	6.2 : 1	8.7 : 1	9.6 : 1
No. of unhatched eggs per fly	4.5	23.0	72.0	23.3

Marking of flies demonstrated two cases of change in the mite population of flies liberated on rock pipits. One, with some 10 mites and 100 eggs when released, had about 30 mites and 70 eggs on recapture 18 days later. The other was free of mites on release and had 10 mites and some 180 eggs after 12 days. By contrast, 48 mite-free flies remained so after periods of 1–12 days on rock pipits.

From these observations it can be concluded that the larvae return to the bird immediately upon hatching. In the meantime there is a good chance the fly will have moved to another bird of the same species and a much smaller chance it will have moved to a different species.

The following records were obtained from migrant birds: dunlin (*Calidris alpina* (L.)) 13.VIII.1955, empty egg shells; tree pipit (*Anthus trivialis* (L.)) 7.IX.1956, 2 mites, 26 eggs, 26 egg shells.

Strelkoviacarus quadratus. This species was overwhelmingly characteristic of flies from wheatears. Frequency on flies from twites is greater than on flies from pipits and starlings, but numbers are too small to be conclusive. Occurrence was mainly on the legs and ventral surface of the thorax; occas-

ionally the neck, but never the abdomen. They were not firmly attached. Highest number recorded on one fly was 90. Only 9 of 165 flies had more than 20; the 1954 mean number per infested fly was 9.4. When birds carried several flies, usually all were mite-infested or none was. For example, on two birds with 6 and 7 flies none was infested; on one with 10 flies all were infested. Of 105 wheatears with flies, 82 had flies with mites. This is probably close to the proportion of birds infested with mites. In 1954, 68% of the ♂♂ and 66% of the ♀♀ were infested. The degree of infestation increases to a peak in early August and thereafter declines. This decline, however, coincides with the beginning of migration from the north and may not reflect the true situation in the local breeding population. At the peak of mite infestation during both years about 80% of the flies were infested. The mean number of mites per fly examined during the peak period was 12 in 1954 and 8 in 1955.

Only females were found. During a preliminary study in 1953, two flies from different wheatears were observed carrying frills of eggs associated with mites, one around the neck, the other around the base of a leg. They probably belonged to this species although specimens were not preserved. One other example involved a single egg and 4 *S. quadratus* attached under the head of a fly.

Of 11 marked flies released and recovered on wheatears 9 gained specimens of *S. quadratus* before recapture (TABLE 9), and 2 remained void of mites. None was recaptured with fewer mites than they were carrying on release. The corresponding figures for flies released on rock pipits are: none gained mites, 32 with no mites on release or recapture, 4 lost some mites, as TABLE 9 shows, and 12 lost all mites (one case cited in the table). For meadow pipits the figures are: none gained mites, 7 with no mites on release or recapture, 12 lost all mites. This confirms the absence of *S. quadratus* on pipits, but also shows they will leave the fly when it is on other than the preferred host. Similar changes occurred on flies that changed hosts before recapture.

Other species of mites. Four specimens of *P. hipposideros* were found on 3 flies from 3 wheatears. Two of these were a male and tritonymph female in copulation.

TABLE 9. Changes in number of *S. quadratus* on some marked flies on Fair Isle, 1954–55.

Host	No. of Mites		Time Interval
	On release	On recapture	
Wheatear	2	57	11 days
(*Oenanthe oenanthe*	1	26	11 days
(L.))	14	48	8 days
	2	8	7 days
	3	32	2 days
	0	10	14 days
	0	1	6 days
	0	2	5 days
	0	14	22 hours
Rock pipit	15	1	6 days
(*Anthus spinoletta*	10	1	4 days
(L.))	7	0	4 days
	11	9	1 day
	6	4	4.5 hours

DISCUSSION

If credence is given to Bequaert's (1953) hypothesis, we must assume that the function of the mite-fly-bird association is to effect the distribution of mites from bird to bird without the latter's physical contact. This could very well be the situation since what is known of the mite-bird specificity is comparable to the fly-bird specificity.

Mites probably are not distributed with equal abundance throughout the British Isles, although lack of certain species at one locality and their presence at another has not been shown yet to be connected with the presence or absence of specific flies or specific birds. The preference by mites for flies from certain species of birds is strongly indicated, as is also the preference for different flies. It must be remembered that within particular geographical limits the species of flies are restricted to a certain range of hosts, although outside these limits the same species of bird may be infested by a different fly. Distribution of mites and the fly-bird relationship is obviously of some complexity and cannot be resolved until much more detailed collecting data are available.

The presence of fewer mites on *O. fringillina* males than on females may be a direct consequence of the difference in seasonal occurrence between the fly sexes correlated with the period of abundance of the mites, or there may be an actual preference for female flies. It was shown by Hill (1963) that *O. fringillina* females were less active than males, which might make them more accessible to the mites. However, from a dispersal point of view Corbet (1956) demonstrated that *O. chloropus* females tended to change hosts far less frequently than males (♀♀ 18%; ♂♂ 52%). If this situation is general in bird flies, then females would be far less effective as dispersal agents than would males.

Strelkoviacarus critesi. This was the commonest mite at Gibraltar Point but unknown at Fair Isle. It was recorded more often on flies from whitethroats than from dunnocks. Mites usually situated on legs and thorax of flies; eggs were never found. This species was more or less equally abundant throughout the season. Attachment to the fly was loose, and mites were often quite active. Females appear not to feed while on flies, hence, cannot be called parasitic. They do not use the fly as a direct means to transport eggs to another bird, but they may use the fly as a means of self-dispersal. Their presence on flies may, on the other hand, be accidental and of no real ecological significance.

Strelkoviacarus quadratus. Common at Fair Isle, it is most frequent on flies from wheatears and resembles *S. critesi* in features as attachment site, tenacity on flies, seasonal abundance, and relationship to flies. Eggs only rarely found.

Myialges macdonaldi. Not recorded at Fair Isle, it was common at Gibraltar Point, and most frequent on *O. fringillina* from dunnocks and whitethroats. It was taken from a greater variety of hosts than the more abundant *S. critesi* (11 species to 5), and was the only mite found on *O. avicularia.* Infestations on 3 *O. avicularia* were considerably higher than on *O. fringillina.* This could result from the larger size of *O. avicularia* offering more sites for attachment.

Adult female is a hyperparasite, feeding on fly's blood. It was found only on the fly's abdomen, firmly attached by mouthparts and claw of tarsus I. Female mite was usually surrounded by egg mass and appeared to use the fly as means of dispersing eggs. This mite, scarce the first 5 weeks of the season, was abundant later. Evidence from Evans et al. (1963) indicates male and immature stages are well adapted for living in the bird's skin. The female, however, on attaining maturity undergoes many morphological changes, adapting to a different mode of life. After changing from a short-legged, spiny, *Sarcoptes*-like nymph to a long-legged, agile adult, she presumably leaves the bird's skin and attaches herself to the abdomen of a fly in the plumage, then takes her first meal.

After sexual maturity is reached each female lays a large number of eggs around herself; each egg being firmly attached to the insect integument by a long stalk. It is probable that the larvae, hatching later in the season, will return to a bird's skin to burrow and feed. In this species (and probably this genus) the males and immature females are skin parasites of birds, whereas adult females are exclusively parasitic on hippoboscid flies.

Microlichus avus. Uncommon at Gibraltar Point, it occurred only on *O. fringillina* from young whitethroats. It was found mostly under the wings at the base with a few on the sides of the thorax. At Fair Isle it was practically confined to flies from starlings and was usually found on the neck and thorax. Heavy infestations were found in large clusters on the anterolateral corners of the dorsal surface of the abdomen; eggs were never found.

Microlichus uncus. This mite was quite common on *O. chloropus* from pipits and twites at Fair Isle. Always found under wing at base, and some 30% had eggs attached nearby. During the latter part of the season an increased proportion of eggs had hatched, but larvae were never found on flies.

Genus *Microlichus* might be expected to be skin-dwelling in the male and immature stages, but little information is available on this. However, Henry & Guilhon (1939a, 1939b) recorded a case of a serin (*Serinus serinus* (L.)) with a classical mange resulting from pathological infestation of *Mi. avus.* Mites, in all stages of development, were found in large numbers in the hollowed-out feather calami. Büttiker (1949) states, without supporting evidence, that the *Mi. uncus* female sucks haemolymph from the fly's basal wing veins. We had no evidence that mites ever fed while on flies. Their association appears phoretic rather than parasitic. In the case of *Mi. uncus* the association seems to be of value as a means of egg dispersal, whereas for *Mi. avus* the adult females would be the only stage being dispersed.

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Addendum: After our paper went to press we received a copy of Fain's (1966) comprehensive review of the family Epidermoptidae. This work prompted re-examination of our material with the following comments.

Microlichus avus (Trouessart). Our specimens are smaller and have smaller plates. The propodosomal plate is about as long as wide and apodemes of coxae I are not contiguous. This may be a new species but requires males for positive determination.

Microlichus uncus Vitzthum. Our specimens appear very close to *Myialges* (*Promyialges*) *pari* Fain in respect to size of idiosoma, shape of hysterosomal plate, length of external scapular setae, development of humeral shield and uniting of apodemes of coxae III-IV. However, other features such as size of propodosomal and hysterosomal plate and shape and length of epigynium were more characteristic of *My.* (*P.*) *uncus*.

Myialges anchora Trouessart and *Myialges macdonaldi* Evans, Fain & Bafort. Our specimens agree with the redescriptions given by Fain (1966).

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