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Fur mites of the genus **Schizocarpus** Trouessart, 1896 (Acari, Chirodiscidae) parasitic on the American beaver **Castor canadensis** in Indiana, U.S.A.*

by A. FAIN**, John O. WHITAKER jr*** and M.A. SMITH***

For many years the only fur mite recognized from beavers, genus *Castor*, was *Schizocarpus mingaudi*. However, Dubinina (1964 a) examined beavers (*Castor fiber*) from Russia and found a total of 12 species of *Schizocarpus*, seven of them fairly well restricted to specific parts of the beaver's body. The purpose of this work, therefore, was to examine beavers, *Castor canadensis*, from Indiana, to determine the status and distribution of *Schizocarpus* mites there.

Eight species of fur mites of the genus *Schizocarpus* Trouessart, 1896 (Chirodiscidae) were collected from American Beavers, *Castor canadensis* from Indiana, U.S.A. Among them seven are new, the eighth is *Schizocarpus mingaudi* Trouessart, 1896, a species described from a Beaver from California.

In this paper we describe the seven new species, redescribe *S. mingaudi*, and we designate a lectotype for this latter species.

Our descriptions are based mainly or exclusively on male specimens. The females and immatures in the various species of *Schizocarpus* are similar to one another and very difficult or impossible to separate. We hope that by collecting more material we will be able to identify these stages. This complementary study will be published later.

All our measurements are in microns (μm). The width is the maximum width of the idiosoma.

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The holotypes of the new species described herein are deposited in the United States National Museum, Washington, D.C. (USNM).

Review of the literature

The genus *Schizocarpus* Trouessart, 1896 a, was created for a single species *Schizocarpus mingaudi* Trouessart, 1896a. The first description (1896a) was short and without figures. In a second paper (Trouessart, 1896b), figures of the male and the female were given and the description was completed. Concerning the identity of the host, Trouessart mentioned : « J'ai découvert l'espèce sur des peaux de *Castor* appartenant au Museum et provenant de Rio Sacramento (Californie). J'ai retrouvé le même type parfaitement identique, sur un Castor du Rhone... » The typical slide is labelled (written by Trouessart in his own hand) : « *Schizocarpus mingaudi* ♂, ♀, ♀ acc. Sur *Castor fiber*, Californie ». It appears thus that the origin of the species is California. The type host is therefore *Castor canadensis* and not *Castor fiber*, although Trouessart mentioned that *S. mingaudi* was also present on *Castor fiber* from the Rhone in France. We have not seen these specimens and we (A.F. and also F.S. Lukoschus, pers. comm.) have not found this species among specimens of *Schizocarpus* collected from several Beavers from Europe and Asia. Dubinina (1964a) redescribed *S. mingaudi* from specimens collected on *Castor fiber* in U.S.S.R. Her drawings of these specimens differ from the true *S. mingaudi* mainly by the more anterior situation of the pair of setae situated between the opisthogastric shields. It is possible that these specimens represent a new species.

The genus name *Schizocarpus* was rejected by Dubinina (1964), who preferred the apparently older name *Histiophorus* Friedrich (1895). Fain (1970) examined the literature and arrived at the conclusion that *Schizocarpus*, published in January 1896, has priority over *Histiophorus* which was published in March 1896.

Lawrence (1948) described *Prolabidocarpus canadensis* n.g. and n.sp. from specimens from *Castor canadensis* from Canada, but the same author in 1959 recognized that his species was in fact *Schizocarpus mingaudi*.

Dubinina (1964a), collected from 22 Beavers (*Castor fiber*) in Voronezh State Reservation, U.S.S.R., twelve species of mites of the genus *Schizocarpus* (= *Histiophorus*), among them *S. mingaudi* and eleven new species. She noted that determination of the species was possible only from characters of the copulatory organs of the males. These different species were not randomly distributed or mixed, but seven of them occupied different specific microareas on the host. Microareas were as follows for the seven species : *S. capitis* Dub. located on the head, *S. numerosus* Dub. on the head and dorsum, *S. fedjushini* Dub. from the flanks, *S. brachyurus* Dub. on the abdomen and legs, *S. brevicauda* Dub. on the median part of the abdomen between anterior and posterior legs, *S. latus* Dub. on the posterior part of the body behind the legs and *S. grandis* Dub. in three small areas, one near the ear, the second on the abdomen in front of the posterior legs and the third close to the anal area. Not enough information was present to determine if the remaining five species occupied specific microareas.

In the same paper, and more extensively in a second paper (1964b), Dubinina described the life-cycle of *Schizocarpus*. She observed six different stages : adult male, adult female, a male-nymph with normal legs and without copulatory discs, a female-nymph sacciform with vestigial legs and copulatory discs, a male-larva with normal legs and no copulatory discs, and a female-larva with normal legs and copulatory discs.

Fain (1971) described the life-cycle of the genus *Labidocarpus* Trouessart, which is close to *Schizocarpus* but lives on bats. This life-cycle differs from that of *Schizocarpus* as described by Dubinina by the presence of four nymphs instead of two. There is a male-protonymph, a male-tritonymph, a female-protonymph and a female-tritonymph. We also found these four types of nymphs from North American Beavers (see section on life-cycle).

Remarks on some morphological characters in *Schizocarpus* specimens from *Castor canadensis*

(1) Specialized neotrichial setae of the suctorial area (in males) (fig. 5-9) :

The suctorial area bearing the suckers and other attaching organs has either one or two pairs of small setae. These setae do not belong to the normal anal or dorso-lateral series of setae and we surmise that they are neotrichial. We designate them by the

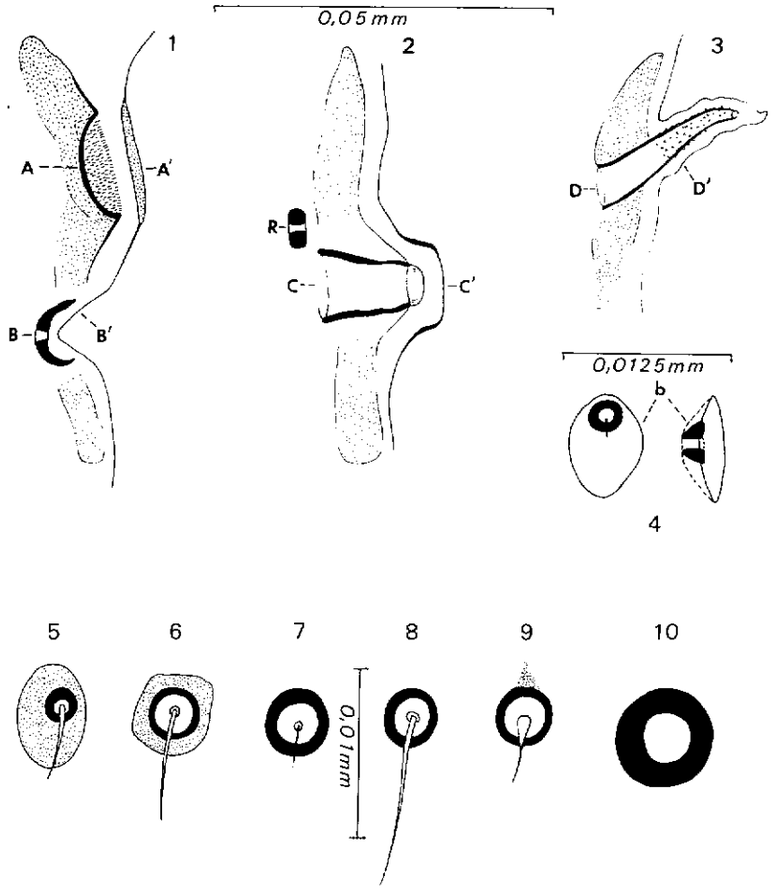

FIG. 1-10.

FIG. 1-3. — Copulatory suckers (A and B) or tubular copulatory organs (C and D) in males, with their corresponding organs in the immatures (A', B', C' and D') in : 1. *Schizocarpus mingaudi* Trouessart ; 2. *S. indianensis* n. sp. ; 3. *S. spinifer* n. sp.
FIG. 4. — Small suckers of type b, in the species of the « *virgulatus* » group : in ventral (to the left) and in lateral (to the right) view.
FIG. 5-9. — Setae *n* in *Schizocarpus virgulatus* n. sp. (5) ; in *S. subvirgulatus* n. sp. (6) ; in *S. tetrapilis* n. sp. (7 = *n a* and 8 = *n p*) ; in *S. mingaudi* Trouessart (9).
FIG. 10. — Sclerotized subcuticular ring (R) in the species of the « *indianensis* » group.

letter *n*. There is only one pair of setae *n in* all species except *S. tetrapilis* n. sp. which has two pairs and in *S. spinifer* n.sp. which is devoid of such setae

The setae *n* are situated generally close to the midline and always on the bare cuticle separating the two opisthogastric shields. These setae are never situated on a raised base or socle as is the case in some species described by Dubinina. In *S. indianensis* n.sp. and in *S. tetrapilis* n.sp. there is a subcuticular small but strongly sclerotized ring situated either in front or behind the main sucker (R). The role of this organ is unknown.

(2) Copulatory organs in the males :

In all species of the genus studied herein the opisthogaster of the male bears either one or two pairs of specialized organs serving for attachment by the larva or nymphs of the female line. These organs are generally situated on two punctate shields. More laterally the opisthogaster is surrounded by apparently two pairs of large transparent membranes. Some of these copulatory organs are true suckers but others are in the shape of sclerotized cylindrico-conical tubes or of shallow or flat rounded or oval discs with wide openings. The role of these formations in the attachment of the immatures is not clear. One can distinguish five different types of attaching organs :

A. Type A organs (or suckers) (fig. 1A, 21) :

They consist of a pair of rounded or oval flat or shallow discs or depressions with a flat and punctate bottom and surrounded by a thick ring. In lateral view this bottom appears more or less brush-like and formed of numerous and very thin hair-like elevations set close together. The immatures of the female line bear at their posterior extremity two flat or slightly raised and punctate discs which correspond in position with these structures of the male.

According to Dubinina (1969) the attachment of the immatures to the male is realized by means of a press-button system, the disc of the immatures being pressed into the suckers of the male. Our observations do not confirm this interpretation. We have never seen the discs of the immatures pressed into the suckers of the male. In all our specimens the discs of the immatures were simply in contact with the suckers of the male. We have also noted that

the discs of the immatures are very often distinctly larger than the suckers of the male making their penetration in the suckers very improbable. We think that the discs of the immatures are maintained in contact by means of a suction produced by the sucker or by a sticky substance secreted by the latter. The suckers of type A are present in all our species except in *S. indianensis*, in *S. tetrapilis* and in *S. spinifer*.

B. Type B Suckers (fig. 1B ; 22).

Type B suckers are well developed but smaller than those of type A. They consist of a short sclerotized funnel deeply sunken into a conical depression of the soft cuticle. A very small canal is visible in the center of the sucker and in most specimens a very small seta is present. In lateral view one can see that the larval cuticle is sucked into sucker B and forms a large cone with a rounded apex (fig. 1B'). Suckers of type B are present only in *S. mingaudi* (= the posterior pair of suckers).

C. Type b Suckers (fig. 4 ; 37a).

Type b suckers have the same structure as suckers B but are much smaller. A pair of suckers b is present in the species of the « *virgulatus* n.sp. » group.

D. Type C Attachment Organs (fig. 2C ; 37).

These consist of a pair of sclerotized cylindrico-conical tubes which are introduced into corresponding rounded depressions existing in the immatures, although the exact mode of fixation is not known. Organs of type C are found in *S. indianensis* n.sp. and in *S. tetrapilis* n.sp.

E. Type D Attachment Organs (fig. 3 ; 26).

Type D attachment organs consist of a pair of relatively long and narrow sclerotized cylindrico-conical tubes bearing on their apical two thirds numerous very small verrucosities. These tubes are deeply introduced in the tissues of the immatures by piercing the cuticle. The verrucosities allow the tubes to be retained in the tissues. Organs of this type have been observed in *S. spinifer* n.sp.

All these suckers or attaching organs (types A, B, C and D) are situated on the two paramedian punctate shields of the opisthogaster. Only the small suckers b are found on the soft cuticle separating these two shields.

(3) Transparent membranes covering the areas of the posterior epimeres.

In the female there is a large transparent membrane covering the area of epimeres IV. In the male a similar membrane covers the entire area involving epimeres III and IV.

The life cycle in the genus *Schizocarpus*

In 1971, Fain described the life-cycle of *Labidocarpus laviae* Fain, 1970, a fur mite from a bat. The genus *Labidocarpus* Trouessart belongs to the same subfamily (Labidocarpinae) as *Schizocarpus*.

The following stages were observed : adult male ; adult female ; female-larva with well-developed legs and copulatory lobes ; male-larva with well-developed legs but without copulatory lobes ; female-protonymph and female-tritonymph, both sacciform with copulatory lobes and vestigial legs II, III and IV ; male-protonymph and male-tritonymph without copulatory lobes but with normally developed legs and resembling closely the adult female. Female-protonymphs were found in the molting stage and containing female-tritonymphs. Molting male-protonymphs were found containing male-tritonymphs, both being separable mainly by the presence in the tritonymph of a solenidion on tibia IV, which was lacking in the protonymph. The adult female was distinguished from the male-protonymph and the male-tritonymph by the presence of a bursa copulatrix opening dorsally close to the anus, and by the larger size of the body.

The development in *Schizocarpus* is the same as in *Labidocarpus*, except that the copulatory lobes in the female-immatures are replaced by copulatory discs.

In examining the male-nymphs of *Schizocarpus* we have found that the situation of the genital setae can provide a good additional character for separating protonymph from tritonymph and the latter from the adult female. In the protonymph, coxae III bear one pair of setae (*cx III*) and coxae IV the setae *g m*. In the tritonymph coxae III bear setae *cx III* and close to the midline the setae *g a* ; coxae IV bear 2 pairs of setae (*g m* and *g p*). In

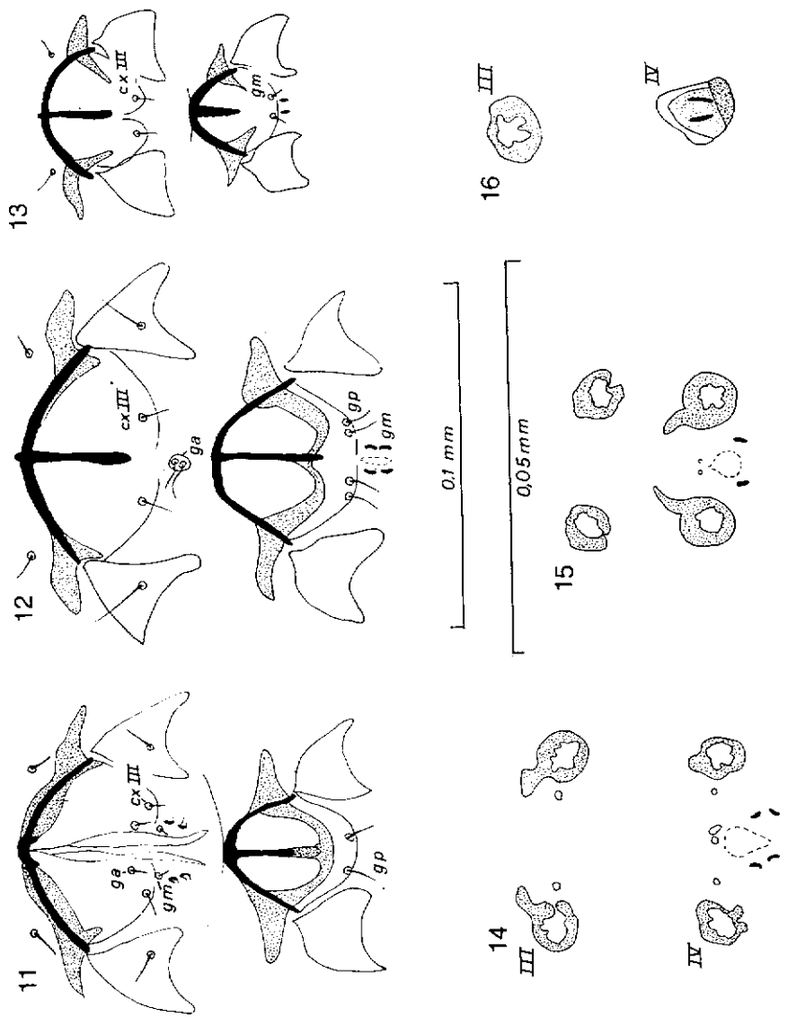

FIG. 11-16

FIG. 11-15. — *Schizocarpus mingaudi* Trouessart.
FIG. 11-13. — Genital setae and remnants of genital suckers in female (11), in male-tritonymph (12) and in male-protonymph (13).
FIG. 14-15. — Legs III and IV, genital setae and genital-suckers remnants in female-tritonymph (14) and in female-protonymph (15).
FIG. 16. — *Schizocarpus indianensis* n. sp.
Female-protonymph : legs III and IV in lateral view.

the female the situation is similar to that of the tritonymph except that setae *g m have* migrated to coxae III, close to the vulva. Also the two pairs of small sclerites representing the remnants of the genital suckers have migrated close to the vulva (fig. 11-13). In addition, trochanters III bear a seta in the male-tritonymph and in the female which is absent in the male-protonymph.

The female-nymphs are more difficult to distinguish from each other. They are sacciform and have very short stumpy legs III and IV. In *S. mingaudi* the female-protonymph (fig. 15) differs from the female-tritonymph (fig. 14) by the following characters : legs III narrower (diameter 6) than legs IV (diameter 7.2) ; with one pair of small sclerites behind and inside of legs IV (remnants of genital suckers) ; only one pair or no small sclerotized rings (vestigial setae) on coxae III-IV. In the female-tritonymphs, legs III are wider (diameter 6.2 to 6.5) than legs IV (diameter 5.8 to 6), there are 2 pairs of small remnants of suckers and 3 to 4 pairs of very small vestigial setae (represented by ringlets). Leg IV of the female-protonymph is prolonged by a short conical membrane visible only in lateral view and more distinct in *S. indianensis* n.sp. than in *S. mingaudi* (fig. 16).

Distribution of the mites on the Beaver

Among the 12 species of *Schizocarpus* recorded by Dubinina from *Castor fiber* in Europe, 7 were found from rather well-defined locations on the Beaver (see above).

In Indiana we have also observed specialized locations for the following species : *S. mingaudi* located mainly on the head and front legs, rarely in other places ; *S. indianensis* n.sp. and *S. tetrapilis* n.sp. on the dorsum and sides of the body from the neck to the tail ; *S. virgulatus* n.sp. located on the inside part of the front legs, on the chest and the abdomen ; *S. subvirgulatus* n.sp. found on the chest and the abdomen, on the inside parts of the front legs and above the hind legs. Information on the distribution and abundance of the mites will be detailed in a separate paper in preparation by Whitaker and Smith.

Study of the species

FAMILY CHIRODISCIDAE TROUESSART, 1892
SUBFAMILY LABIDOCARPINAE GUNTHER, 1942
TRIBE SCHIZOCARPINI FAIN, 1971

Genus *Schizocarpus* Trouessart, 1896
Schizocarpus Trouessart, 1896a : 28 ; Fain, 1970 : 824
Histiophorus Friedrich, 1895 : 433 (published in March 1896)
Haptosoma Kramer, 1896 : 134
Prolabidocarpus Lawrence, 1948 : 369

Definition : With the characters of the Labidocarpinae (see Fain, 1971). Absence of propodosomal shields in both sexes. Male with either one median or two paramedian opisthonotal shields. Anus terminal in both sexes. Female with either one or two pairs of anal sclerites (a ventral and a dorsal). Opisthogaster in male bearing the copulatory organs (suckers or sclerotized tubes) generally situated on two paramedian punctate shields. This suctorial plate is surrounded laterally by large transparent membranes. Penis relatively short and narrow. Legs I-II very short, modified and bearing apically striated membranes. Legs III-IV ending in a pedunculate sucker in both sexes. *Chaetotaxy of the idiosoma* : Present in the female : *sc i, sc e, s cx* (hardly visible and inconstant), *d 1* to *d 5*, *l 1* to *l 5*, *h*, *sh*, *a 1* (= *a i*), *a 2* (= *a e*), *a 3*, *g a*, *g m*, *g p*, *ex I*, *ex III*. Most of these setae are microsetae (*d 1* to *d 4*, *l 2* to *l 4*, *a 2*,*a 3*). In the male the setae *d 1* are lacking. The orifice of the oil gland is situated between *l 2* and *l 3* in males and behind *l 3* in females. The opisthogaster in males bears one or two pairs of additional neotrichial short setae (setae n) and the setae *l 4*, *l 5*, *a 1* and *a 2* which are situated along a punctate band. The *a 3* is situated either in front of the shields or more laterally along the punctate band in front of *l 4*. *Chaetotaxy of legs* : In both sexes only tibia III bears a seta, tibia IV is bare. In the female tarsi III-IV bear 4 thin setae and 1 ventral spine. In the male tarsi III bear 4 thin setae and 2 unequal spines (one ventral, one ventro-apical), tarsi IV bear 2 thin setae and 1 ventral spine. A solenidion is present on tibiae III and IV and on genu III, the latter being lacking in *S. spinifer* n. sp.

Type species : *Schizocarpus mingaudi* Trouessart, 1896.

Hosts : Restricted to holarctic Beavers, in N. America, and reported from Europe, N. Asia (but see discussion of this in literature review). Specialized for living in fur.

Key to the species of *Schizocarpus* of N. America (males)

1. Opisthonotum with two separate paramedian shields ; setae *sc i*, *l 1* and *l 2* spinous ; copulatory organs of type D . . . . . *S. spinifer* n. sp.
   Opisthonotum with one large median shield ; setae *sc i*, *l 1* and *l 2* piliform ; copulatory organs of types A, B, C, or b 2
2. Opisthogaster with two paramedian oval shields each bearing 2 large suckers, an anterior one of type A and a posterior one of type B. A pair of setae *n* on the soft cuticle between the suckers B. Suckers b absent.
   . . . . . *S. mingaudi* Trouessart, 1896
   Opisthogaster with paramedian shields either oval or comma-shaped each bearing only one sucker or copulatory organ 3
3. The shields of the opisthogaster oval, each of them bearing a large ring consisting of a copulatory organ of type C and a small ring situated under the cuticle. The soft cuticle between the shields bearing either one or two pairs of setae *n*. Tarsi IV distinctly longer than wide
   . . . . . group « *indianensis* » . . . 4
   The shields of the opisthogaster comma-shaped (= virgul), formed of a large anterior part and a postero-lateral narrow curved band, the anterior part bearing a type A sucker. The soft cuticle between the shields bears a pair of small suckers of type b and a pair of setae *n*. Tarsi IV approximately as long as wide
   . . . . . group « *virgulatus* » 5
4. With one pair of setae *n*. Opisthogastric shields 8 to 10 apart. Setae *a 2* present
   . . . . . *S. indianensis* n. sp.
   With two pairs of setae *n*. Opisthogastric shields 15 to 20 apart. Setae *a 2* absent
   . . . . . *S. tetrapilis* n. sp.

5. Small suckers b situated behind setae *n*
. 6
Small suckers b situated in front of setae *n*
. 7

6. Setae *n* situated slightly in front and outside of suckers b, both structures are situated far behind suckers A
. . . . . *S. virgulatus* n. sp.
Setae *n* situated far in front of suckers b, both structures situated at the level of suckers A
. . . . . *S. subvirgulatus* n. sp.

7. Postero-lateral prolongation of opisthogastric shield forming a narrow and regular punctate band which is not furcate. Suckers b close to setae *n*, both structures situated behind the level of suckers A
. . . . . *S. inversus* n.sp.
Postero-lateral prolongation of opisthogastric shield furcate. Suckers b far in front of setae *n* and close to the level of the anterior margin of suckers A
. . . . . *S. furcatus* n. sp.

All the new species described herein are clearly different from the species described by Dubinina (1964) from European Beavers, in the males by the shape of the opisthogastric shields, the shape and the situation of the copulatory suckers and of the setae *n*.

Schizocarpus mingaudi Trouessart, 1896
Schizocarpus mingaudi Trouessart, 1896a : 22 ;
Lawrence, 1959 : 111
Haptosoma truncatus Kramer, 1896 : 134
Prolabidocarpus canadensis Lawrence, 1948 : 369

Through the courtesy of Mr. M. Naudo of the Museum of Natural History in Paris, we were able to examine the specimens of Trouessart. The type slide contains a male, a female, and a female-nymph described and figured by Trouessart. The label mentions : « Collection Trouessart. *Schizocarpus mingaudi*, sur *Castor fiber,* Californie ». We select the male as lectotype of the species.

Male (Lectotype) (fig. 17-23) : Idiosoma 325 long and 180 wide (in ventral view). Length and width of opisthosoma 100 ×

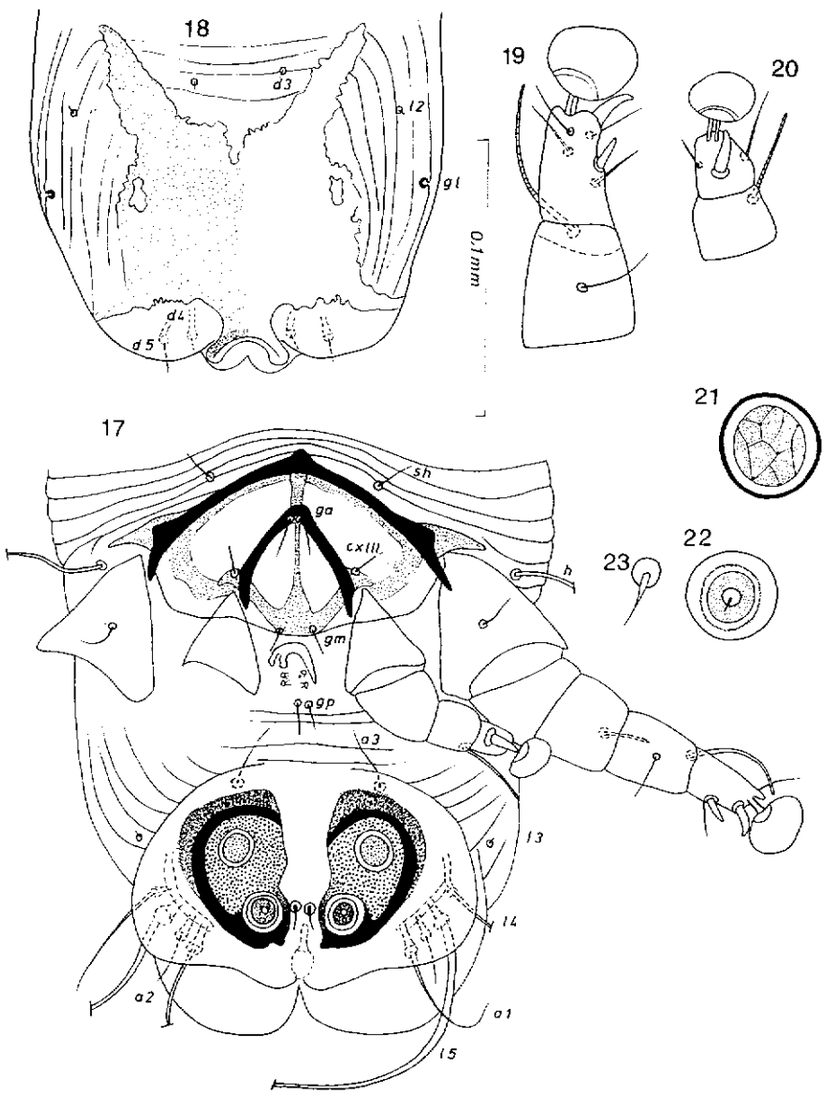

FIG. 17-23. — *Schizocarpus mingaudi* Trouessart. Male : 17, hysterogaster ; 18, opisthonotal shield ; 19, tibia and tarsus III ; 20, tibia and tarsus IV ; 21, anterior sucker A enlarged ; 22, posterior sucker B enlarged ; 23, seta *n* enlarged.

150. Hysteronotal shield 70 long in midline and 87 wide in its median part. Antero-lateral corners of the shield with long and narrow prolongations directed antero-laterally. Opisthogastric shields 54 long and 33 maximum width. They are 15 apart anteriorly and 10 apart in their narrow posterior section. Suckers A slightly oval, greatest diameter 14-15. Posterior suckers B situated in a clear non-punctate area of 15 diameter, the sucker itself is slightly oval and its diameters are 7,5 and 9. Chaetotaxy : Most of the setae (*sc i, sc e, l 1* ; *l 4* ; *l 5* ; *h*) are incomplete. Length of setae *a 1* 50, *a 2* 30. Setae *d 4* and *d 5* very short.

Female (Paralectotype) : Idiosoma 350 long and 180 wide (in oblique view). Most of the setae are incomplete except *h* 72 long, *a 1* 18 and the short genital and coxal setae. Length of tarsi III and IV 15-16.

Specimens from Beavers from Indiana :

We have examined more than 1200 specimens of this species from 10 of 11 Beavers from Indiana. The mites were located mainly from the head, neck, and outside of the front legs. In order to illustrate the chaetotaxy of a female in the genus *Schizocarpus* we give herein a figure of a female of *S. mingaudi* from Beavers JOW no. 11348, from Potato Creek Fish and Game Area, St. Joseph Co., 3 December 1981 (fig. 24-25).

A male found on the same Beaver is 318 long and 150 wide (idioscoma in lateral view). Hysteronotal shield 69 long and 81 wide in its median part. Tarsi III-IV as in the lectotype. Opisthogastric suctorial plate as in lectotype. Chaetotaxy (length of setae) : *sc i* 25 ; *sc e* 10 ; *l 1* 40 ; *h* 80 ; *sh* 20 ; *l 4* 55 ; *l 5* 150 ; *a 1* 48 ; *a 2* 22 ; *a 3* 35 ; *d 4* 5 ; *d 5* 10.

Hosts and localities in Indiana :

A large number of the specimens were collected from *Castor canadensis,* JOW 11348, Potato Creek, St Joseph Co., 3 December 1981. Other specimens were from 4 other Beavers : JOW 11350, La Salle Fish & Wildlife Area, Lake Co., JOW 11394, Winamac Fish & Wildlife Area, Pulaski Co., JOW 11886 and 11887, Willow Slough Fish & Wildlife Area, Newton Co., taken 2 May, 1983.

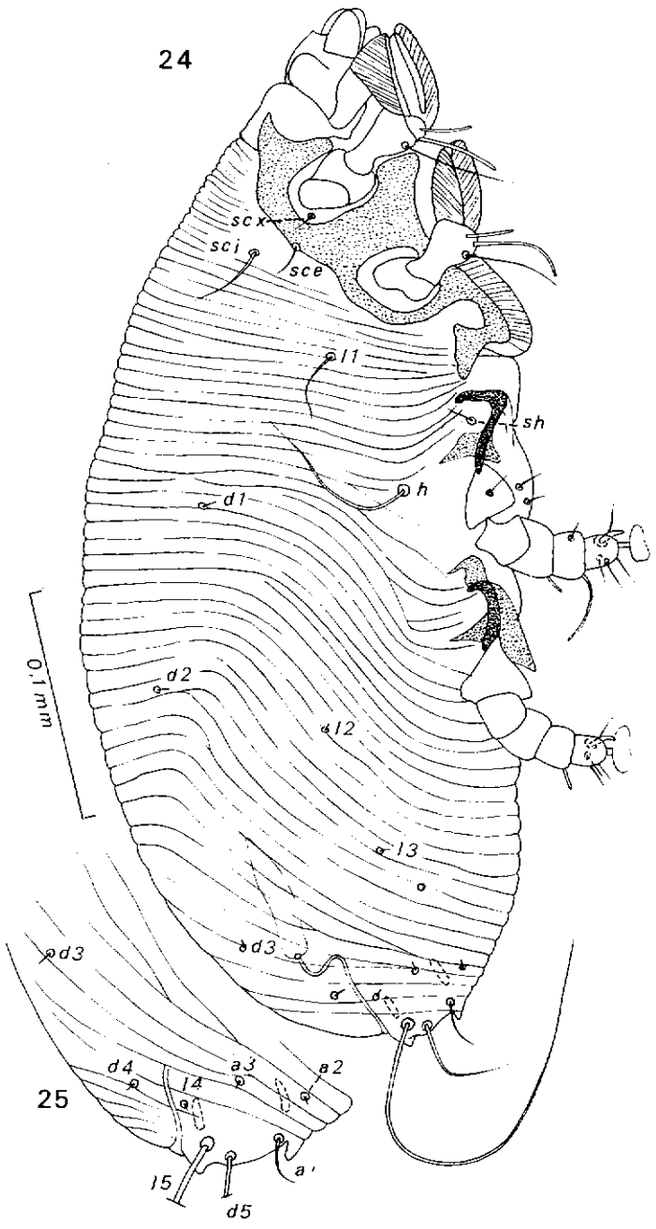

FIG. 24-25. — *Schizocarpus mingaudi* Trouessart. Female : 24, lateral view ; 25, posterior extremity enlarged.

Schizocarpus spinifer nov. spec.

Male (fig. 3, 26-28) : Idiosoma in the holotype 306 long and 196 wide, in lateral view. Opisthonotum with two paramedian separate shields. The opisthogastric area is difficult to observe in this specimen. In a paratype mounted ventro-laterally we have observed two small punctate shields surrounding the long sclerotized tube-like copulatory organs (type D). Length and width of tarsi III 27 × 18 and IV 14 × 14. Chaetotaxi of the idiosoma (length of setae) : *sc i* thick, slightly spinous, 15 long ; *sc e* thin, 15 long ; *l 1* and *l 2* are large spines finely attenuated apically and 22 and 26 long respectively. The other setae are thin and piliform : *h* 90 ; *sh* 15 ; *d 5* 10 ; *l 4* 100 ; *l 5* 140 ; *a 1* 80 ; *a 2* 10. Setae *d 3*, *d 4*, *l 3* are lacking. Genu III without a solenidion. The solenidion of tibia IV is longer (length 30) than that of tibia III (length 18).

Host and locality :

Holotype male and one paratype male from *Castor canadensis*, JOW no. 11348, Potato Creek, St. Joseph Co., Indiana, U.S.A. Three other paratype males from beaver JOW Nos. 11350 and 11734 from LaSalle Fish and Wildlife Area (Lake and Newton counties taken in Sept. 1981 and October 1982, respectively) and JOW No. 11736 from Glendale Fish & Wildlife Area (Pike Co., taken November 1982). We have seen a total of 14 individuals of this species from five beavers, mostly from the abdomen. Holotype in USNM.

Remark :

This species differs from all the other species described in the genus by the presence of two paramedian shields on the opisthonotum, the presence of spines on the dorsal surface of the body and the very specialized aspect of the copulatory organs. Holotype in the USNM.

Schizocarpus indianensis nov. spec.

Male (fig. 2, 29-32) : Idiosoma in the holotype 354 long and 200 wide (in ventral view). Length and width in 4 paratypes in lateral view : 355 × 240, 350 × 215, 336 × 235, and 320 × 215. Opisthonotal shield 78 long in midline and 69 wide

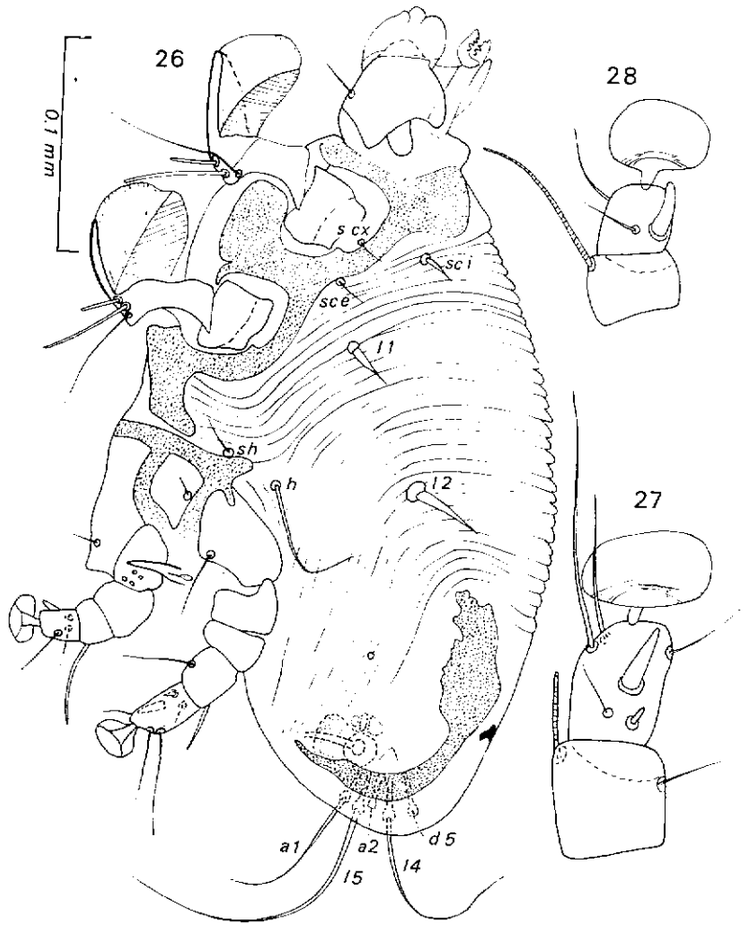

FIG. 26-28. — *Schizocarpus spinifer* n. sp. Male : 26, lateral view ; 27, tibia and tarsus III ; 28, tibia and tarsus IV.

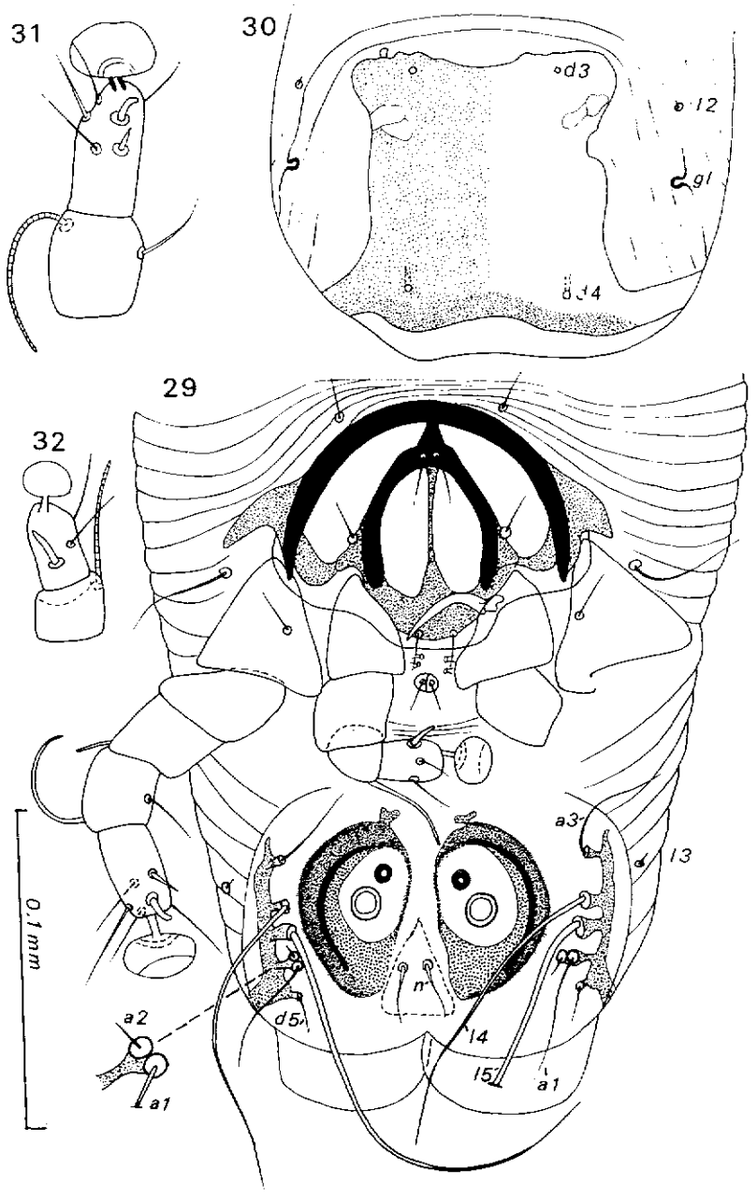

FIG. 29-32. — *Schizocarpus indianensis* n. sp. Male : 29, hysterogaster ; 30, opisthonotal shield ; 31, tibia and tarsus III ; 32, tibia and tarsus IV.

in its median part ; with straight anterior margin and corners not produced. Length of this shield in 4 paratypes : 75 - 80 - 95 - 98. Opisthogastric shields 54 long and 33 wide and 8-10 apart ; they bear a sucker of type C consisting of a cylindrico-conical truncate tube 12 long in lateral view, and 9 wide (maximum). Immediately in front of this sucker but situated more deeply (under the cuticle) is a thick sclerotized ring (diameter 6). There are no suckers of type A, B, b and D. There is a pair of paramedian setae *n* at the level of the posterior third of the shield on the soft cuticle. The ventral anal sclerite is strongly developed. Length and width of tarsi III 30 × 15, of tarsi IV 18 × 15. Chaetotaxy of idiosoma (length of setae) : *sc i* 45 ; *sc e* 10 ; *h* 42 ; *sh* 18 ; *d 5* 4 ; *l 1* 35 ; *l 4* 90 ; *l 5* 135 ; *a 1* 35 ; *a 2* 6 ; *a 3* 40-45 (very lateral).

Variation in the species :

In specimens from JOW 11348 the subcuticular ring on the opisthogastric shields is situated behind the sucker and not in front of this as in the holotype.

Host and localities :

Holotype male and 19 paratype males from *Castor canadensis* JOW 11394, from Winamac Fish and Wildlife Area, Pulaski Co., Indiana, U.S.A., 28 March 1982. The mites were located on the dorsum above the hind legs and on the venter behind the front legs. Other paratype males : 3 from JOW 11438, Winamac, Pulaski County ; 1 from JOW 11886 ; and 45 from JOW 11887, Willow Slough, Newton Co., 2 May 1983 (the mites were located on the mid dorsum) ; 5 from JOW 11348, Potato Creek, St. Joseph Co. ; 6 from JOW 11350, LaSalle, Lake Co., September 1981 ; 1 from JOW 10101, Jasper-Pulaski Fish & Wildlife Area, Jaspar County, 6 September 1976. Holotype in the USNM.

We have examined over 550 individuals of this species. Most were found on the dorsum and sides of the beavers.

Remark :

This species is closest to *S. latus* Dubinina. It differs from it by the presence of a sclerotized subcuticular ring close to the sucker, the lateral situation of setae *a 3*, and the tube-like structure of the copulatory organs.

Schizocarpus tetrapilis nov. spec.

Male (fig. 33-34) : The holotype is in two parts. Its total length (idiosoma) is approximately 365. In 4 paratypes the length × widths are 375 × 210 ; 355 × 200 ; 344 × 185, 340 × 185

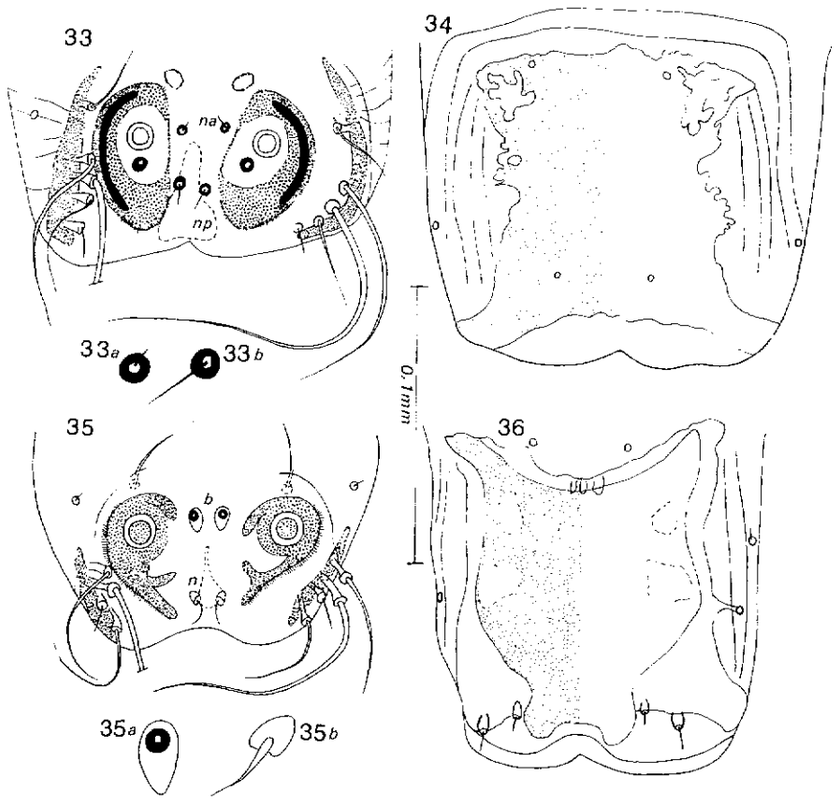

FIG. 33-36

FIG 33-34. — *Schizocarpus tetrapilis n. sp.* Male : 33, opisthogaster ; 34, opisthonotal shield ; 33a and b, setae *n*.

FIG. 35-36. — *Schizocarpus furcatus n. sp.* Male : 35, opisthogaster ; 36, opisthonotal shield ; 35a, sucker b ; 35b, seta *n*.

(all in lateral view). Opisthonotal shield as in *S. indianensis* n. sp. but with more irregular margins, 95 long (in midline) and 75 wide (in median part). Opisthogastric shields 51 long, 30 wide and

15 apart, bearing the same type of suckers as *S. indianensis* n. sp. and also a pair of subcuticular rings but situated behind the suckers. Suckers A, B, b, and D lacking. There are two pairs of small setae *n*, an anterior *n a* and a posterior *n p*, widely separated from each other. Tarsi III-IV as in *S. indianensis* n. sp. Length of setae : *sc i* 40 ; *b* 35 ; *l 1* 35, *l 4* 100, *l 5* 140, *d 5* 8, *a 1* 40, *a 3* 36. Setae *a 2* are lacking.

Host and localities :

Holotype and 11 paratype males from *Castor canadensis*, JOW 11348, Potato Creek, St. Joseph Co., Indiana, U.S.A. The mites were located on the dorso-lateral area of the body. One paratype from a Beaver JOW 11439, Kingsbury, Laporte Co., Indiana. Holotype in the USNM.

We have examined a total of 79 individuals of this species from two beavers.

Remark :

This species is close to *S. indianensis* n. sp. It differs from it by the presence of an additional pair of setae *n*, the absence of setae *a 2* and the greater distance between the two opisthogastric shields.

Schizocarpus virgulatus nov. spec.

Male (fig. 4, 37-40) : Idiosoma in holotype 302 long and 150 wide (in ventral view). In 4 paratypes the length × width is 330 × 150, 310 × 46 (both in ventral view) ; 301 × 160 and 296 × 142 (both in lateral view). Opisthonotal shield with anterior border concave and the two anterior corners produced ; length in the midline 90, width in its median part 78 ; posterior margin with the median third excavated. Opisthogaster with two shields comma-shaped, each bearing a sucker of type A, slightly oval (diameter 10.5 × 9). The anterior part of the shield is prolonged posterolaterally by a narrow curved punctate band. The soft cuticle behind the suckers bears a pair of small paramedian suckers of type b and more laterally and slightly more in front a pair of small setae *n*. Length and width of tarsi III and IV 21 × 12 and 10 × 10 respectively. Length of setae : *sc i* 12, *sc e* 10, *l 1* 25, *l 4* 50, *l 5* 120, *b* 40, *a 1* 40, *a 2* 18, *a 3* 30.

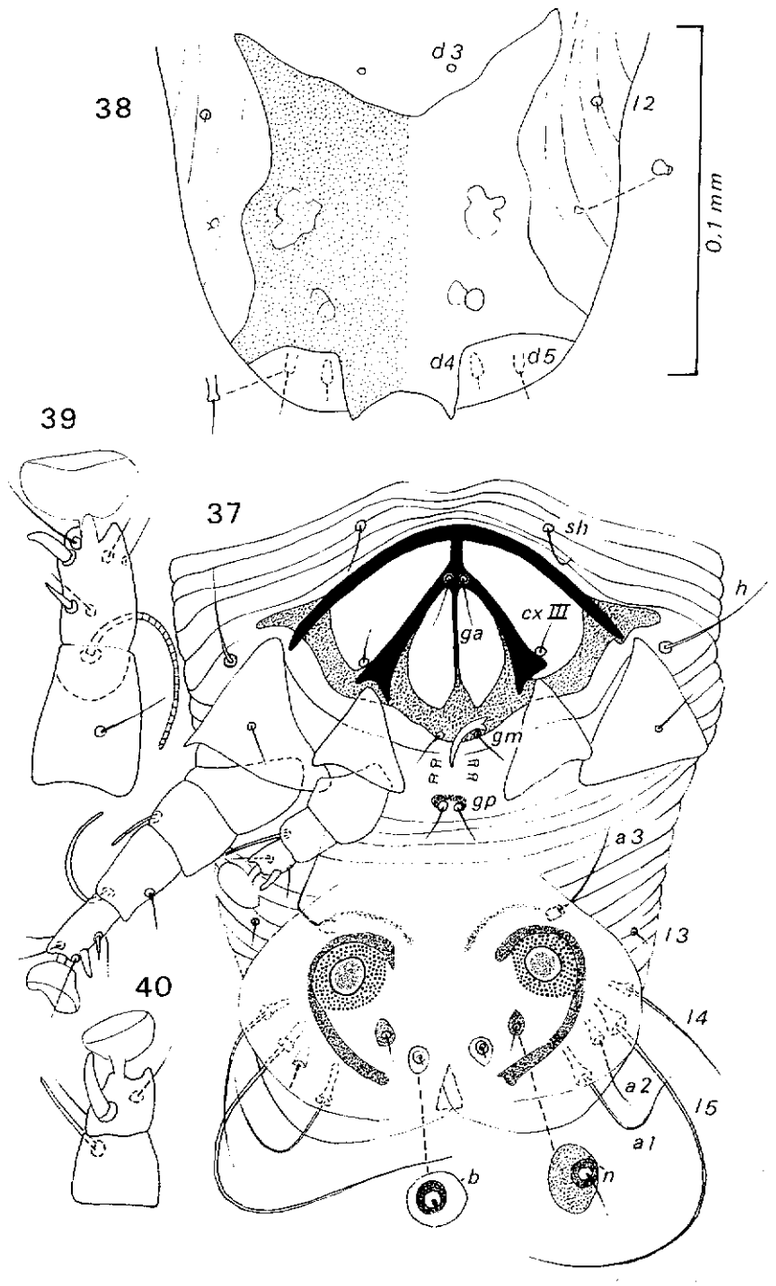

FIG. 37-40. — *Schizocarpus virgulatus* n. sp. Male : 37, hysterogaster ; 38, opisthonotal shield ; 39, tibia and tarsus III ; 40, tibia and tarsus IV ; 37a, sucker b ; 37b, seta *n*.

Hosts and localities :

Holotype and 23 paratype males from a Beaver, *Castor canadensis*, JOW 11348, Potato Creek, St. Joseph Co., Indiana, U.S.A., 3 December 1981. The mites were located on the abdomen, chest and inside of the front legs.

We have examined 70 individuals of this species. Holotype in USNM.

Remark :

This species belongs to a group of 4 species characterized by the comma-shape (= in virgul) of the opisthogastric shields, the presence of a pair of suckers of type A, a pair of small suckers of type b and one pair of small setae *n* situated either in front or behind suckers b. This combination of characters is not encountered in any of the species described by Dubinina (1964).

Schizocarpus subvirgulatus nov. spec.

Male (fig. 41-42) : Idiosoma in the holotype 288 long and 156 wide (in ventral view). In 5 paratypes (length × width) : 315 × 160, 305 × 158, 304 × 151, and 288 × 150 (in ventral view) ; 298 × 158 (lateral view). Opisthosoma 77 long and 120 wide at its base. Opisthonotal shield as in *S. virgulatus* n. sp. but the setae *n* are situated in front of the suckers b and the latter are more anterior. The posterior band-like prolongation of these shields is shorter than in that species. Length and width of tarsi III and IV : 22 × 12 and 9 × 9 respectively. Length of setae (in type and paratypes) : *sc i* 15, *sc e* 8, *l 1* 25, *l 4* 40, *l 5* 150, *a 1* 50, *a 2* 10, *a 3* 30, *h* 35, *d 5* 8.

Host and localities :

Holotype and 19 paratype males from *Castor candensis*, JOW 11394, Winamac Fish and Game, Pulaski Co., Indiana, U.S.A., 24 March 1982. The mites were located on the venter just behind the front legs and above the hind legs. Other paratypes : 8 males from Beaver JOW 11348, Potato Creek, St. Joseph Co., Indiana, 3 December 1981. We have seen a total of over 400 mites of this species, all from the abdomen and insides of the legs. Holotype in USNM.

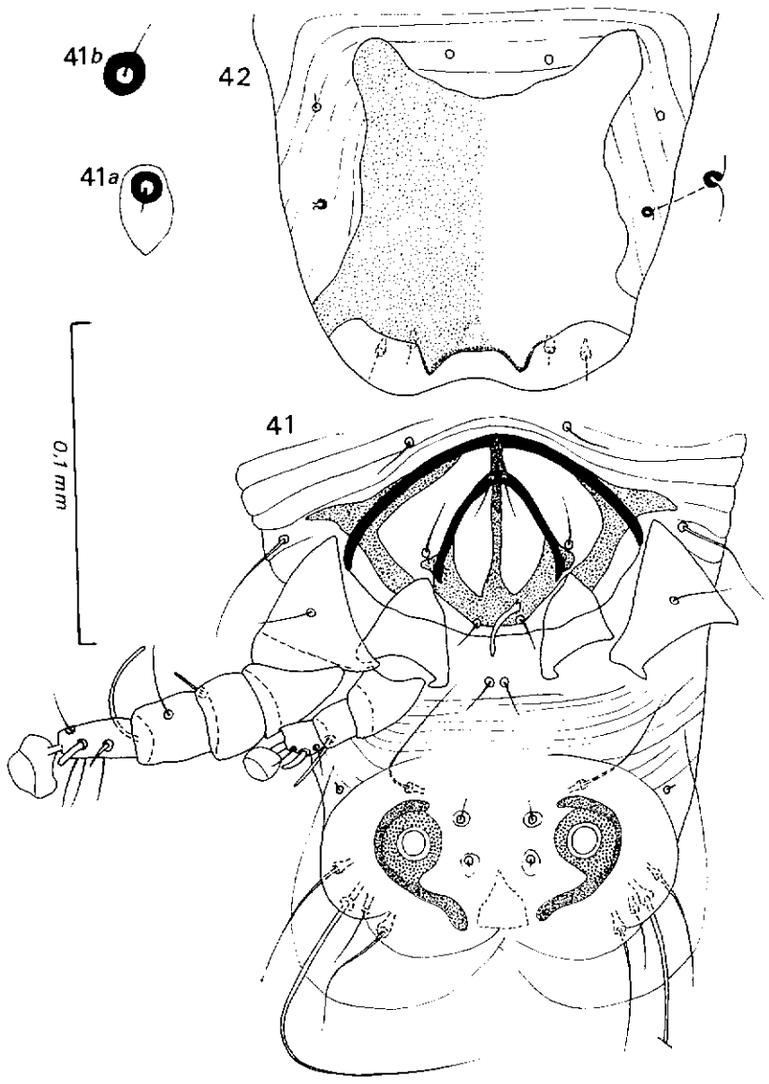

FIG. 41-42. — *Schizocarpus subvirgulatus* n. sp Male : 41, hysterogaster ; 42, opisthonotal shield ; 41a, sucker b ; 41b, seta *n*.

Remark :

This species differs from *S. virgulatus* mainly by the more anterior and paramedian situation of the setae *n* and the shorter length of the postero-lateral curved prolongation of the opisthogastric shield.

Schizocarpus inversus nov. spec.

Male (fig. 43-44) : Idiosoma of the holotype 275 long and 150 wide (in ventral view). In 2 paratypes (length × width) 286 × 140 and 288 × 180 in lateral view ; these specimens are strongly flattened. Opisthosoma 75 long and 130 wide. Opisthonotum bearing a median shield wider (96) than long (85). Opisthogastric shields as in *S. virgulatus* n. sp. The small suckers b are situated in front of setae *n*, both structures being paramedian and situated behind the anterior large part of the shield. Length and width of tarsi III and IV 21 × 15 and 11.5 × 10.5 respectively. Length of setae (in holotype and paratypes) : *sc i* 18, *sc e* 8, *l 1* 22, *l 4* 45, *l 5* 130, *d 5* 8, *h* 38, *a 1* 50, *a 2* 18, *a 3* 30.

Host and locality :

Holotype and 2 paratype males from *Castor canadensis*, JOW 11736, from Glendale Fish and Wildlife Area, Pike County, taken in November 1982. Holotype in the USNM.

Remark :

This species clearly differs from *S. virgulatus* n. sp. and *S. subvirgulatus* n. sp. by the inverted situation of the suckers b which are in front of the setae *n*, and not behind the latter as in these species (hence the name « *inversus* » for the species).

Schizocarpus furcatus nov. spec.

Male (fig. 35-36) : Idiosoma in the holotype 300 long and approximately 150 wide (in ventral view). This specimen is slightly distorted. Length and width in 3 paratypes : 294 × 165, 290 × 160, and 280 × 155, all in lateral view. Opisthonotal shield 87 long (in midline) and 84 wide in median part ; its anterior margin concave and anterior corners produced ; it is less solerotized along its lateral and anterior margins ; its posterior

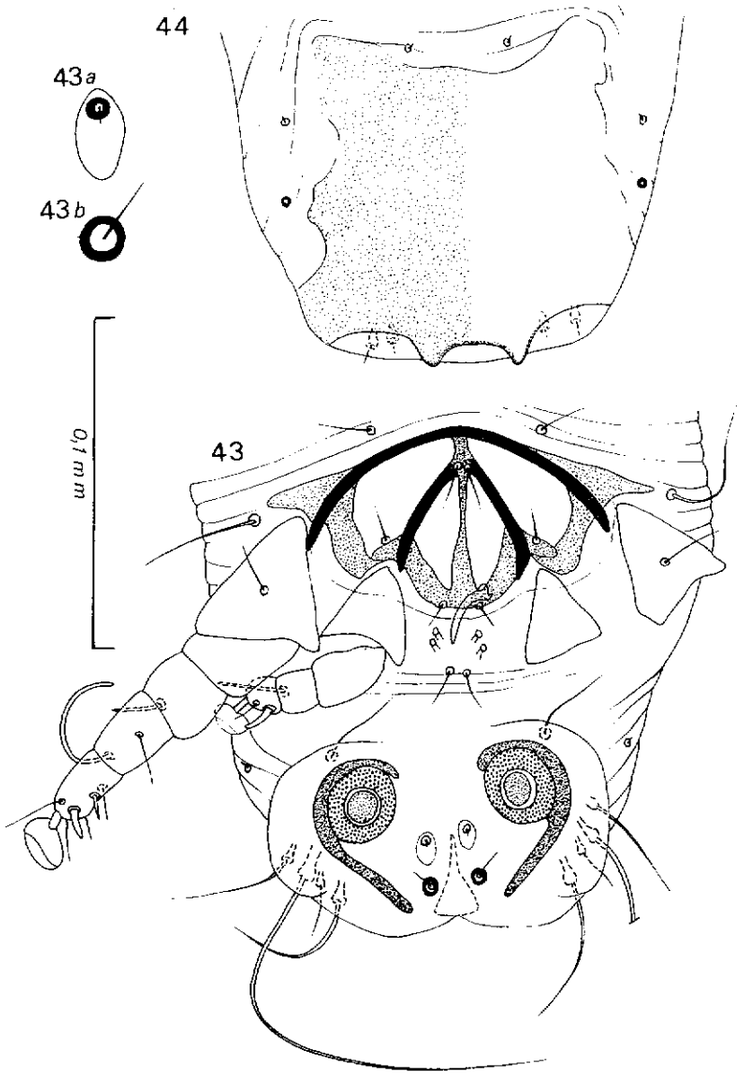

FIG. 43-44. — *Schizocarpus inversus* n. sp. Male : 43, hysterogaster ; 44, opisthonotal shield ; 43a, sucker b ; 43b, seta *n*.

margin excavated in its median third which is also more sclerotized. Opisthonotal shields comma-shaped with the postero-lateral curved prolongation forked posteriorly. Suckers b situated far in front of setae *n*. Length and width of tarsi III and IV 24 × 15 and 12 × 11 respectively. Length of setae : *sc i* 15-20, *l 1* 25, *l 4* 50, *l 5* 150, *d 5* 8, *h* 40-50, *a 1* 40, *a 2* 20, *a 3* 32.

Host and locality :

Holotype and 4 paratype males from *Castor canadensis*, JOW 11736 from Glendale Fish & Wildlife Area, Pike County, Indiana, taken in November 1982. Holotype in USNM.

Remark :

This species is distinguished from *S. inversus* mainly by the furcate shape of the punctate curved stripe prolonging the opisthogastric shield posteriorly, and by the far more anterior situation of the suckers b relative to setae *n*.

Remarks on the specificity of the genus *Schizocarpus*

The specificity of the genus *Schizocarpus* is very strict. The 20 known species of this genus are strictly confined to beavers. This well-defined group of rodents belongs to a single genus *Castor* L., forming the family Castoridae. This genus contains two species, a Palaearctic, *Castor fiber* L. 1759, and a Nearctic, *Castor canadensis* Kuhl, 1820.

The specificity of *Schizocarpus* is also very strict at the species level. The 12 species described from *C. fiber* have been found only on this beaver and the 8 species living on *C. canadensis* are confined to this animal (assuming the palaearctic *S. mingaudi* to differ from that in the nearctic region).

So far the relationships between the two species of Castor have been much debated. Some authors believe that they are specifically distinct while others consider them to be conspecific. According to Lavrov and Orlov (1973) the two species are clearly distinct from each other by the form of the skull and the different number of chromosomes (see Corbet, 1980). Our observations on the specificity of their fur-mites of the genus *Schizocarpus* provide a new argument in favour of the separation of the species.

Castor canadensis was formerly widespread in all the forested areas of North America to Mexico, but at present it has disappeared from many places. In addition, there have been numerous movements of this animal by man.

Acknowledgements

We thank M. Michel NAUDO, Muséum National d'Histoire Naturelle, Paris, who sent us the types of *Schizocarpus mingaudi* for our study.

Summary

Eight species of fur mites of the genus *Schizocarpus* Trouessart, 1896 (Chirodiscidae), were collected from the Beaver, *Castor canadensis*, from Indiana. Seven of these were new and are here described. A lectotype is deisignated for *Schizocarpus mingaudi* Trouessart, 1896, the type species of the genus. The different species occupy specific areas on the host as was the case in the observations of Dubinina (1964a) on the species from the European Beaver. Some characters insufficiently known and important in the separation of the species are described and figured and the life-cycle is described.

Résumé

Huit espèces d'acariens pilicoles du genre *Schizocarpus* Trouessart, 1896 (Chirodiscidae) ont été récoltés sur *Castor canadensis* d'Indiana, U.S.A. Sept sont nouvelles et décrites. Un lectotype est désigné et décrit pour *S. mingaudi* Trouessart, 1896 l'espèce type du genre. Les différentes espèces occupent sur l'hôte des régions déterminées comme ce fut le cas pour les espèces décrites du Castor d'Europe par Dubinina (1964a). Certains caractères d'importance systématique sont décrits en détail et figurés et le cycle du développement est précisé.

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