THE SYSTEMATICS AND GEOGRAPHIC DISTRIBUTION OF EAST AFRICAN VEIGAIIDAE (ACARINA : MESOSTIGMATA)

BY Henry W. HURLBUTT *

VEIGAIIDAE
ETHIOPIAN
REGION
ORIENTAL
DISTRICT

ABSTRACT : Three species of *Gamasolaelaps* (*cerviformis, whartoni* and *bondwaensis* n. sp.) and three species of *Veigaia* (*exigua, planicola* and *uncata*) are reported from East Africa. Four of the veigaiids, all unisexual, are widely distributed outside Africa while the two bisexual species are known only from East African mountains. A comparison of several morphological characters in *G. whartoni* and *V. planicola* (both unisexual) from East Africa and eastern United States showed that variation within regions exceeded differences between continents. A key to the world species of *Gamasolaelaps* is included and differences separating members of the *V. exigua* complex are described. Altitudinal distributions of unisexual and bisexual veigaiids are compared.

VEIGAIIDAE
RÉGION
ÉTHIOPIENNE
SECTEUR
ORIENTAL

RÉSUMÉ : Trois espèces de *Gamasolaelaps* (*cerviformis, whartoni* et *bondwaensis* n. sp.) et trois espèces de *Veigaia* (*exigua, planicola* et *uncata*) sont signalées de l'Afrique Orientale. Les quatre Veigaiidae parthénogénétiques sont répandus largement hors de l'Afrique, mais les deux formes bisexuées ont été trouvées seulement dans les monts de l'Afrique Orientale.

Les femelles de *G. whartoni* et *V. planicola* (toutes les deux unisexuées) de l'Afrique Orientale et des États Unis de l'Est sont comparées ; elles sont identiques. Une clé de détermination de toutes les espèces de *Gamasolaelaps* est donnée, et les différences entre les formes du groupe des *V. exigua* sont citées. Les distributions des Veigaiidae parthénogénétiques et bisexués en fonction de l'altitude sont comparées.

The mesostigmatid family Veigaiidae is a predominantly Holarctic group of free-living mites which includes three very unequal sized genera, *Veigaia, Gamasolaelaps* and *Cyrthydrolaelaps*. The largest genus, *Veigaia*, has over forty described species and is one of the commonest genera of mites in the forest soils of eastern North America. It is also plentiful in the Palearctic region (BREGETOVA, 1961, 1974 ; KARG, 1971), but is virtually unknown in the tropics, although BHATTACHARYYA (1967, 1972) reported three species from India. *Gamasolaelaps*, although much smaller than *Veigaia* in regard to number of species (eleven), seems to be rather scattered zoogeographically, species having been described from Europe, Siberia, Japan, Africa, southern United

* Department of Biology, West Virginia University, Morgantown, West Virginia, U.S.A.

States, Jamaica, Argentina and the subantarctic. *Cyrthydrolaelaps*, which according to HUNTER (1970) has six species, is characteristic of intertidal areas. It is not known from Africa and will not be considered in the present paper. Until now, only two species of veigaiids have been reported from tropical Africa, *Gamasolaelaps cerviformis* by EVANS (1959) and *Veigaia uncata* by BREGETOVA (1961). In addition, NEL and RYKE (1970) list *Gorirossia* sp. from an estate in South Africa. *Gorirossia* is a synonym of *Gamasolaelaps*.

The chief purpose of the present paper is to describe the few species of Veigaiidae known from East Africa. Since four of these, all unisexual, appear very similar to forms occurring outside Africa, African and nonafrican forms are compared and their taxonomic status clarified. Several species of *Gamasolaelaps* have been described since the paper by EVANS (1959) on *Cyrthydrolaelaps* and *Gamasolaelaps*. Therefore, a key to the known species of the latter genus is included.

Materials. Most of the material examined for this study was collected by myself from Tanzania and Kenya. Dr. BLOCK and Dr. HOWELL also supplied specimens. Type material located in the Berlese collection in Florence, Italy, the British Museum of Natural History (BMNH) in London and the U.S. National Museum (USNM) in Washington was examined with the help of Dr. FAUSTA-PEGAZZANO, Dr. HYATT and Dr. BAKER. The holotype of *Gamasolaelaps bondwaensis* n. sp. is in the U.S. national Museum. Specimens of *G. whartoni*, along with a small collection of other Mesostigmata from Tanzania, have been sent to the University of Dar es Salaam, Tanzania.

Most morphological terms, especially names of dorsal setae and parts of the gnathosoma, follow EVANS and TILL (1979). The conspicuous structures behind coxa IV in veigaiids are variously referred to as precoxal plates (BREGETOVA, 1961), punctiform organs (FARRIER, 1957) and glande inguinale = gv_2 (ATHIAS-HENRIOT, 1971). In this paper FARRIER'S descriptive term is used.

Mites in which males are not known to occur are referred to as " unisexual ". Presumably the unisexual veigaiids reproduce by thelytokous parthenogenesis in which unfertilized eggs develop into females. Arrhenotoky, parthenogenesis in which haploid males are produced from unfertilized eggs but females arise from fertilized eggs, also occurs in some Mesostigmata, but it is not known if any veigaiids are arrhenotokous.

GAMASOLAELAPS BERLESE 1904

Gamasolaelaps (= *Gorirossia* Farrier, 1957) can be distinguished from *Veigaia* by the following features ; genitoventral shield of the female composed of a single part which is basically flask-shaped and separated from the anal shield by a membranous seta-bearing region ; internal malae not fringed ; leg II of males without spurs or apophyses. Since the 1959 review of EVANS, species have been described by BREGETOVA (1961), BALOGH (1963), KARG (1965), McGRAW and FARRIER (1969), HUNTER (1970) and ISHIKAWA (1978). Eleven species are known at present two of which, *G. multidentatus* and *G. subcorticalis*, are very similar. Chaetotaxy and body size are the same in these two mites and both have an inside row of fine teeth on the fixed digit of the chelicera, but *G. multidentatus* has a divided dorsal shield and the tectum is more serrate.

KEY TO FEMALES OF *Gamasolaelaps*

1. Sternal shield bearing only two pairs of setae, third sternal setae arising from separate plates. Southern Argentina, South Georgia I.....
   G. shealsi Balogh (= *G. arenosus* Hunter **n. syn.**)
— Sternal shield bearing three pairs of setae..... 2
2. Genitoventral shield with seven pairs of setae, femur IV with small tubercle. Russia.....
   G. tuberculatus Bregetova

— Genitoventral shield with one to three pairs of setae. 3

3. Moveable digit of chelicera with at least seven teeth, median part of sternal shield weakly sclerotised. 4

— Moveable digit of chelicera with five or less teeth. 6

4. Anterior dorsal shield with 15 pairs of setae, idiosoma over 500 μm. Argentina..... *G. bisternalis* Balogh

— Anterior dorsal shield with 18 pairs of setae, idiosoma under 500 μm..... 5

5. Dorsal shield completely divided. Germany..... *G. multidentatus* Karg

— Dorsal shield not completely divided. United States, Mexico.. *G. subcorticalis* McGraw and Farrier

6. Genitoventral shield of female with one pair of setae ; gnathosomal setae forming a nearly straight longitudinal row ; tectum characteristically shaped (fig. 5). East Africa..... *G. cerviformis* Berlese

— Genitoventral shield with two to there pairs of setae ; gnathosomal setae not in a straight line ; tectum with two or three main tines..... 7

7. With two separate dorsal shields, anterior shield with small lateral incisions ; genitoventral shield usually with five setae. Europe, Siberia..... *G. excisus* (Koch)

— Dorsal shield not completely divided ; genitoventral shield with four or six setae..... 8

8. Tarsus I without trichocyst ; tectum three-tined. Jamaica. ..... *G. bellingeri* Evans

— Tarsus I with trichocyst ; tectum two-tined..... 9

9. Genitoventral shield with three pairs of setae, posterior pair much longer than anterior two pairs ; idiosoma under 370 μm. Africa, southern United States, Russia, Japan..... *G. whartoni* (Farrier)

— Genitoventral shield with two pairs of setae of approximately equal length ; idiosoma over 450 μm. Tanzania. ..... **G. bondwaensis** n. sp.

Gamasolaelaps cerviformis Berlese (fig. 5)

Gamasolaelaps cerviformis BERLESE (1916). Redia, 12 : 159.

G. cerviformis has been thoroughly described and illustrated by EVANS (1959) from specimens from the Ruwenzori Mts., Uganda. I have examined BERLESE'S type, which is in excellent condition, plus several specimens from Mt. Kilimanjaro and these agree with EVANS'S description. Distinctive features of *G. cerviformis* include the peculiar tectum (fig. 5), the arrangement of the hypostomal setae in a parasagittal line and the characteristic shapes of the ventral shields in both sexes. Measurements of the type female are as follows : idiosoma 650 μm, j1 58 μm, j3 (= i2) 38 μm, st3-st3 94 μm, seta on ventral shield 45 μm, distance between these setae 105 μm. In BERLESE'S male the most posterior setae on the ventral shield are not the edge but about 10 μm anterior to the edge of the shield ; also the anterior part of the sternal shield projects laterally more than shown by EVANS.

Females from Mt. Kilimanjaro are as follows : body length 690-755 μm ; sclerotization of posterior part of dorsal shield variable but darker than other parts of shield. Setal measurements as in type female ; distance between setae on genitoventral shield 100-110 μm, st3-st3 = 95-97 μm. Chelicerae very long (total length = 550 μm) and slender, moveable digit 100 μm long and unidentate. Tarsus I wich long, slender bent hair arising from apex of a capsule (trichocyst). The capsule is partly below and partly projecting above the surface of the tarsus.

Material examined. Type ♀, ♂ same slide, Africa orientale, in Berlese collection. Three ♀♀, two ♂♂, Mt. Kilimanjaro, Tanzania, forest litter, 2100 m., 10 June 1972 and one ♀ ex moss, soil from forest above Mandara (Bismark) Hut, 2800 m., 19 June 1972 by H. HURLBUTT. One ♀ Aberdares National Park, Kenya, under St. Johns wort, 3500 m. by W. BLOCK.

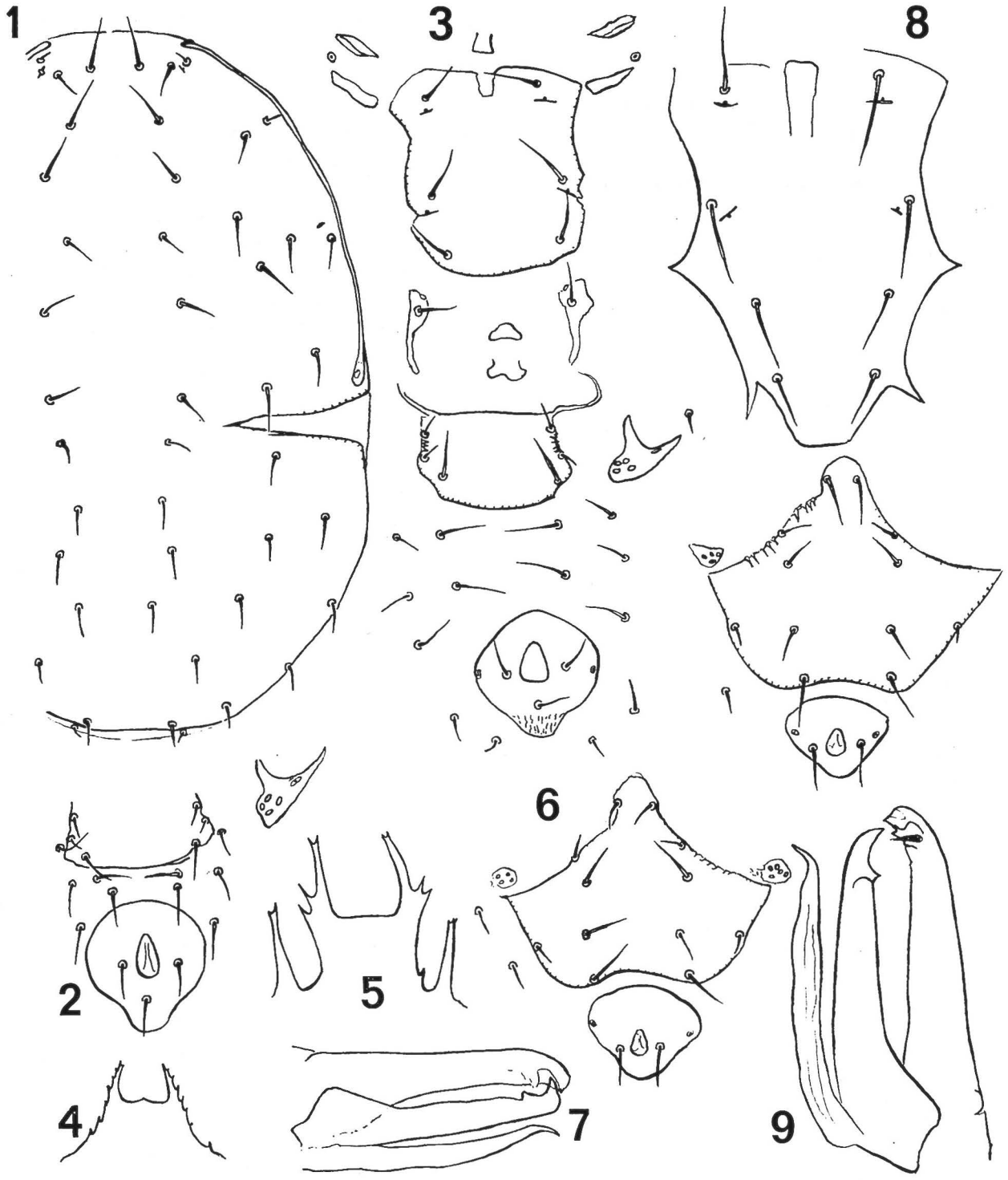
Gamasolaelaps whartoni (Farrier) (figs. 1-4)

Gorirossia whartoni FARRIER, 1957, N. Carolina Agr. Exp. Sta. Bul., 124 : 90-92.

Gamasolaelaps pygmaeus BREGETOVA, 1961, Parasitol. sbornik Zool. Inst. Akad. nauk SSSR, 20 : 99-100. **New synonym.**

Gorirossia cooki WOODRING, 1964, Proc. Louisiana Acad. Sci., 27 : 5-8. **New synonym.**

Gamasolaelaps ctenisetiger ISHIKAWA, 1978, Annotationes Zoologicae Japonensis, 51 : 100-102. **New synonym.**



FIGS. 1-2 : *Gamasolaelaps whartoni* (Farrier), type ♀. 1) dorsal shields ; 2) ventrianal region.
FIGS. 3-4 : *Gamasolaelaps whartoni*, ♀ from Tanzania. 3) venter ; 4) tectum.
FIG. 5 : *Gamasolaelaps cerviformis* Berlese, ♀ from Mt. Kilimanjaro, tectum.
FIGS. 6-7 : *Gamasolaelaps* sp. near *bondwaensis*, ♂. 6) venter ; 7) chelicera.
FIGS. 8-9 : *Gamasolaelaps bondwaensis* n. sp., ♂. 8) venter ; 9) chelicera.

■ *Females* (from Tanzania). Idiosoma 320-350 μm long. Dorsal shield with lateral incisions, anterior part 190 μm long, with 16 pairs of setae, posterior dorsal shield with 13 pairs of setae. Dorsal setae similar in length and thickness, j1 23-25, j2 and j3 23, j4, j5 and j6 18-20, z6 22, J1 13 μm long.

Sternal shield weakly sclerotized, with indentation in middle of anterior margin, st1-st3 69-77 μm, st1-st1 46-53 μm. With two pairs of conspicuous rectangular plates and one pair of pores between coxa I and anterolateral corner of sternal shield. Metasternal shields elongate posteriorly, with seta and lyrifissure. Genitoventral 45 × 70 μm, slightly convex posteriorly, with three pairs of setae, the two more anterior ones on lateral edge of shield. Punctiform organ (= precoxalplates or inguinal gland) with four pores (= solenostomes of gv_2). Seta behind stigma 11 μm. Membranous area between ventral and anal shields with five pairs of setae. (In some specimens including the type from North Carolina one of these setae appears very close to the posterolateral corner of the ventral shield due to folding of the idiosoma). Membrane between anal and posterior dorsal shields with three pairs of setae.

Tectum with two tines, lateral edges of tectum strongly serrate. Moveable digit of chelicera 33-34 μm, with five teeth, fixed digit with four medium, four minute teeth. Hypostome with three pairs of lateral grooves, each bearing long fine teeth, hypognathal groove indistinct, palpcoxal setae 26 μm. Inner seta on palp femur bent, comblike, with ten teeth on medial side. Inner setae on palp genu spatulate, with small teeth apically. Tarsus I excluding stalk 95-102 μm long, with long, slender, bent hair (trichobothrium of EVANS, 1959). Tibia IV 79-87 μm, longest distal seta on tibia IV 50-56 μm. Tarsus IV 115-122 μm.

■ *Male.* Unknown.

■ *Material examined.* Holotype (USNM) and one paratype (BMNH) from leaf mold, Carthage, North Carolina. One ♀ (type of *G. cooki*) from lichen on tree trunk, Tangipahoa Parish, La. by J. WOODRING. Ten ♀♀ ex litter from pink, oak, palmetto forest, Land of Lakes, Florida, March 1973 by N. KOWAL. One ♀ ex soil under papyrus, Katawana Swamp and two ♀♀ Kipogera and Bulesi Swamp, Uganda by W. BLOCK. Nine ♀♀ ex litter and banana bark under coffee trees and 13 ♀♀ ex forest litter, 1300 m., Lyamungu, Tanzania, 10 June 1972. I also collected *G. whartoni* from the following habitats near Morogoro, Tanzania : leaf litter, edge of Morogoro River, 550 m ; soil under grass and thicket, 1100 m. ; soil and leaves under weeds near stream west of Morningside, 1350 m. : dead leaves, twigs and soil near stream, rain forest. Uluguru Mts., 1450 m ; leaf litter under *Myrianthus*, 1600 m.

■ *Remarks.* Specimens of *Gamasolaelaps whartoni* appear identical to descriptions of *G. pygmaeus* BREGETOVA and *Gorirossia cooki* WOODRING except that serrations are not shown on the edges of the lateral tines of the tectum in *G. pygmaeus*. Both BREGETOVA (1961) and WOODRING (1964) referred to the apparent absence of precoxal shields (= punctiform organs) in *G. whartoni*, but although not included in FARRIER'S drawing they are present in the type of this mite. Recently ISHIKAWA (1978) described *G. ctenisetiger* from several localities in southern Japan and Ryukyu. This mite also appears identical to *G. whartoni* except for the apparent absence in *ctenisetiger* of a tiny pair of setae on the anterior margin of the anterior dorsal shield and another pair of setae on the posterolateral margin of the posterior dorsal shield. Palps, ventral sclerotization, chaetotaxy and measurements all agree. Therefore, *G. pygmaeus, cooki* and *ctenisetiger* must all be regarded as junior synonyms of *G. whartoni* (FARRIER).

G. whartoni seems to thrive in swampy areas. It is often very abundant and in many samples from Tanzania was the most frequent species of mesostigmatid mites present. It has not yet been collected at elevations above 1600 m.

The measurements of 16 ♀♀ collected from Morogoro, Tanzania in April and May, 12 ♀♀ from Lyamungu, Tanzania in May, and 10 ♀♀

from Florida in March were compared (Table 1). The samples from Morogoro and Florida did not differ significantly from each other in the lengths of the idiosoma, tarsus IV, tibial seta or seta V_1. Length of tibia IV and seta j1 did differ significantly (p less than .01) between Morogoro and Florida, but not between samples from Florida and Lyamungu, Tanzania. In fact, the differences between the two localities in Tanzania regarding these characters were greater than those between Lyamungu and Florida. None of the differences was large enough to warrant subspecies recognition using criteria suggested by MAYR (1969).

TABLE 1. — Comparison of *Gamasolaelaps whartoni* from Tanzania and United States. Averages and standard deviations in microns.

Locality		Idiosoma	tIV[1]	tbIV	tb seta	V1	j1
Morogoro, Tanzania	$\bar{X}$	331	118.1	84.4	53.2	24.1	24.3
(N = 16)	S. D.	10	2.3	1.9	1.7	0.7	0.9
Lyamungu, Tanzania	$\bar{X}$	336	119.0	82.3	52.6	24.3	23.6
(N = 12)	S. D.	11	1.9	1.4	1.8	0.6	0.6
Florida	$\bar{X}$	334	118.4	80.5	54.1	24.1	23.4
(N = 10)	S. D.	11	3.8	3.7	1.4	1.0	0.7
North Carolina	type	330	112	80	—	—	23

1. Length of tarsus IV not including ambulacrum.

Gamasolaelaps bondwaensis n. sp.
(Figs. 8-16)

■ *Female.* Dorsal shield with distinct lateral incisions, anterior part 350 μm long, with 17 pairs of setae on shield, membrane lateral to shield at level of coxae III with small seta. Posterior part of dorsal shield 270 μm long, sclerotization irregular posteriorly. Color varying from gold to dark orange. In more heavily sclerotized individuals the posterior and lateral portions of the posterior dorsal shield are more heavily sclerotized than the central part. Setae j1 64 μm, j5 and j6 50 μm, stouter and longer than other setae.

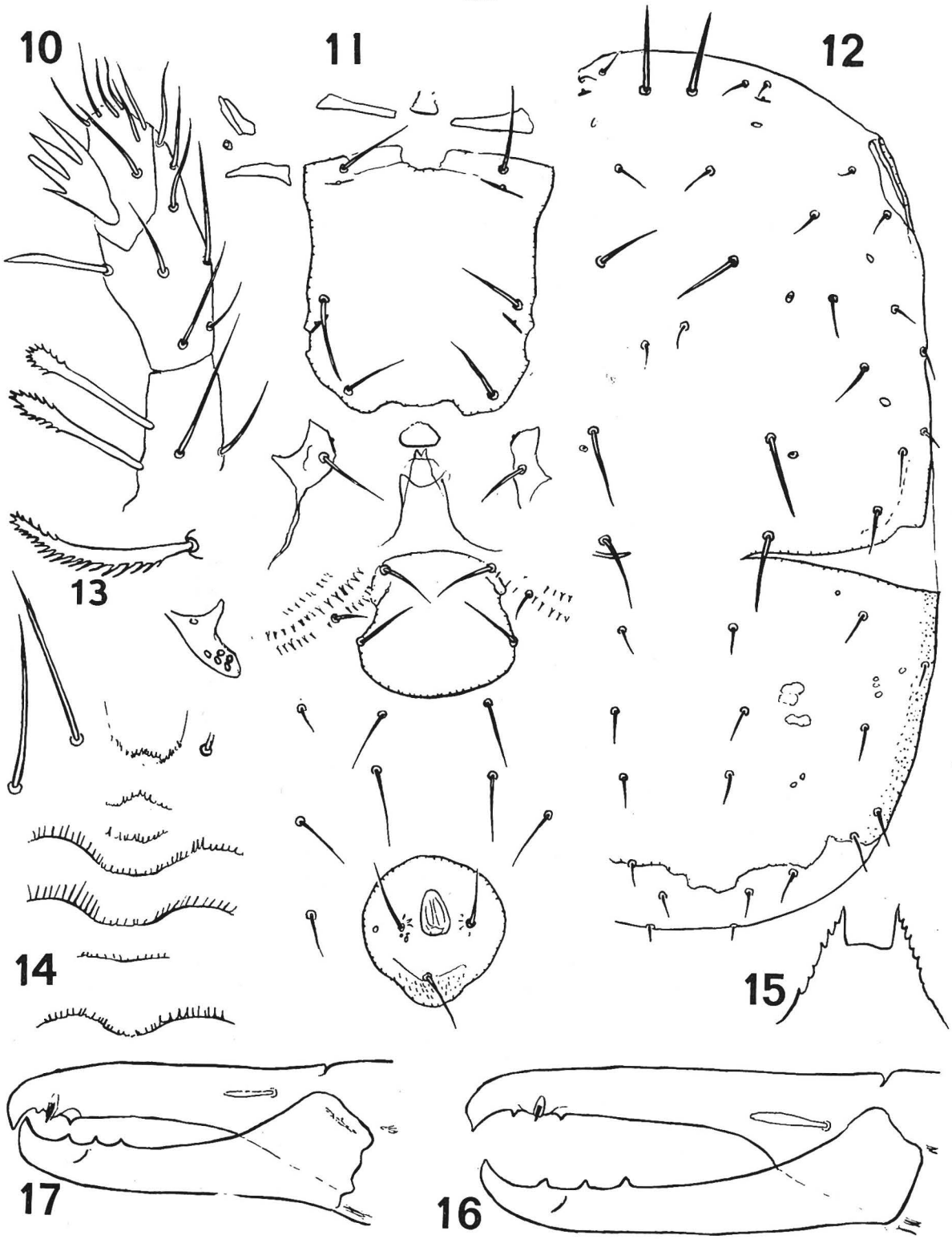
Sternal shield 160 μm long at midline, 143 μm wide at level of st2, uniformly sclerotized, slightly indented at anterior margin. One pair of weakly sclerotized preendopodals present. Genitoventral shield 110 × 90 μm, with two pairs of setae. Membrane between ventral shield and punctiform organ with three rows of fine denticles. Punctiform organ variable even in the same specimen, with three, four or five pores. Seta behind stigma 12 μm, arising from membrane.

Tectum with two tines, toothed laterally. Moveable digit of chelicera 102 μm long, with three teeth, curved notch between first and second teeth. Fixed digit with three low teeth subapically. Total length of chelicera about 320 μm. Hypognathum with seven transverse rows (fig. 14). Hypostomal setae not in a vertical row, palp coxal setae 57-60 μm long. Setae on palp trochanter strong, inner seta on palp femur strongly comblike with about 15 pairs of prongs, inner setae on palp genu comblike distally. Palp tibia with spatulate but untoothed inner seta.

Leg I (excluding ambulacrum) 970 μm long, tarsus I 190-200 μm, with very slender, long, bent hair arising from trichocyst 80 μm from base of tarsus. A similar and probably homologous hair on tarsus I of the deutonymph of *Veigaia nemorensis* is illustrated by ATHIAS-HENRIOT (1969). Femur IV with seven, genu and tibia IV with ten setae. Leg IV 1100, tarsus IV 260-300 μm, long distal seta on tibia IV 150-170 μm.

■ *Male.* Idiosoma 490-510 μm long, dark gold, with 18 pairs of dorsal setae on anterior portion, j1 stout, 54 μm. Dorsal shield without lateral incisions, posterior margin indistinct. Peritreme 250 μm long, anterior two-fifths of peritremal shield fused to dorsal shield. Sternogenital shield 195 μm long, with four pairs of setae, st1-st3 125 μm. Ventral shield widest just behind punctiform organ (fig. 8), with six pairs of setae. The three most anterior pairs of setae on the ventral shield are 26, 16 and 23 μm long. Anterolateral edge of shield bordered by two rows of fine denticles. Punctiform organ with either four or five pores.

Tectum with two broad tines which are toothed laterally. Moveable digit of chelicera 65-77 μm long, with subapical tooth, fixed digit with hollowed out recess for tip of moveable digit. Spermatodactyl not extending past tip of moveable



FIGS. 10-16 : *Gamasolaelaps bondwaensis* n. sp., ♀. 10) palp genu, tibia and tarsus ; 11) venter ; 12) dorsal shields of holotype ; 13) inner seta on palp femur ; 14) hypognathum ; 15) tectum ; 16) chelicera.

FIG. 17 : Chelicera of *Gamasolaelaps* sp. near *bondwaensis*.

digit. Hypognathum with seven transverse rows (= Querlinie of HIRSCHMANN), Q4, Q5 and Q6 wider and more conspicuous than other rows. Palpcoxal seta 52-55 μm. Palps as in female. Leg II unarmed, without spines or humps. Tarsus I 175-185 μm long, with specialized hair and trichocyst as in female. Tarsus IV 285 μm, longest seta on tibia IV 150 μm.

■ *Material examined.* Three males and four gravid females including holotype ex moss, 2125 m., Mt. Bondwa, Uluguru Mts., Tanzania 30 May 1972. One ♂, three ♀♀ ex leaf litter, same locality, 1 May and 10 June 1968. One ♀ Mt. Bondwa, April 1980 by K. HOWELL.

■ *Remarks.* Four females and one male from Mt. Bondwa are substantially smaller in several measurements than *G. bondwaensis*. The hypostome, chelicerae and chaetotaxy agree in the minutest detail with the exception of the anterior most setae on the ventral shield of the male.

VEIGAIA OUDEMANS 1905

Females of *Veigaia* may be recognized by the distinctive genitoventral shield which is divided into two portions which are usually fused laterally but are separated medially by a transverse membranous area. Gland gv_2 (the punctiform organ of FARRIER) with multiple solenostomes or "pits" behind coxa IV. The internal malae are fringed and leg II of the males bears spurs. With over forty described species *Veigaia* is one of the largest and commonest genera of soil mesostigmatids in the Holarctic region, but only three species, none endemic, occur in tropical Africa.

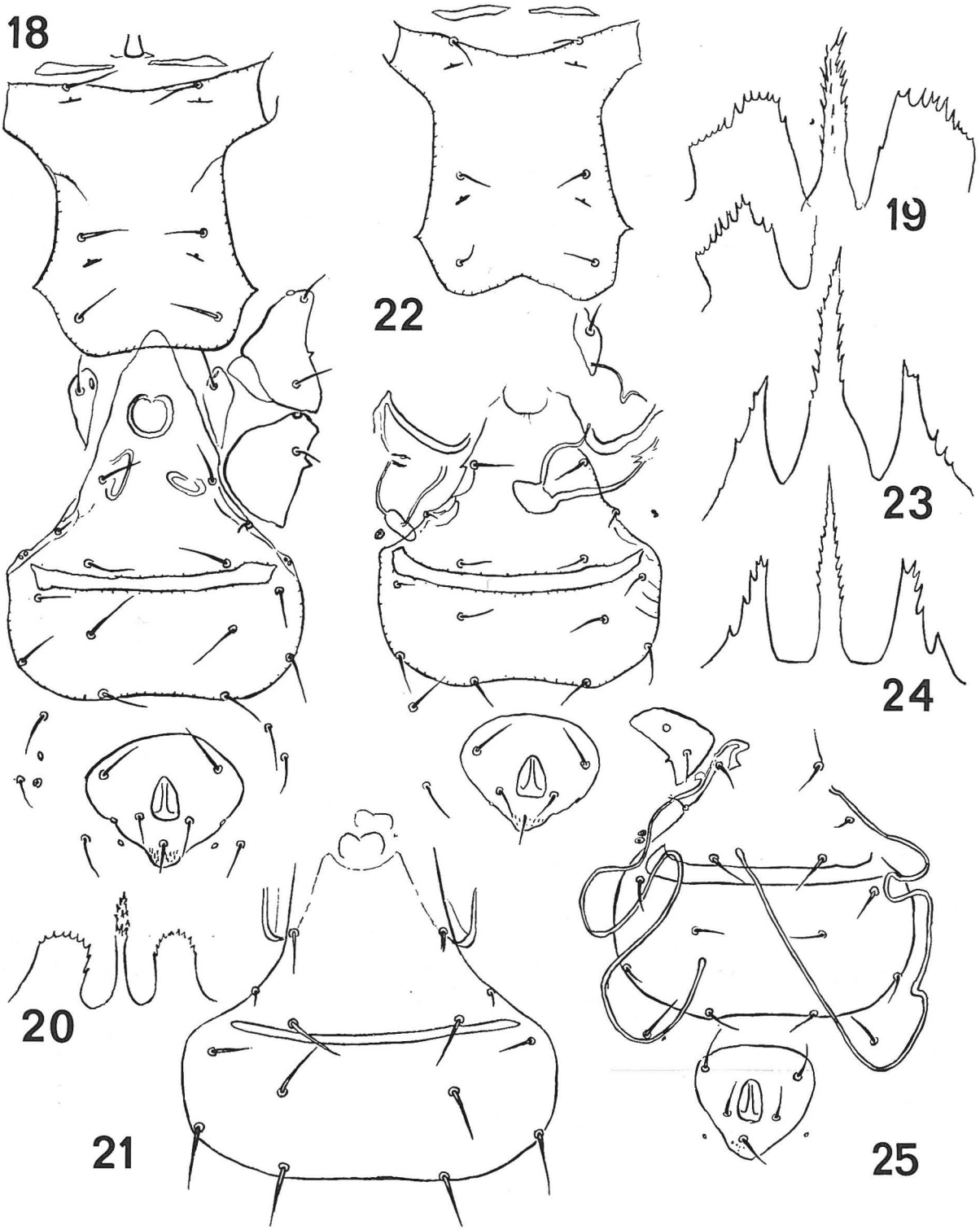
Veigaia exigua (Berlese)
(figs. 18-21)

Cyrtolaelaps exiguus BERLESE, 1916, Redia, 300-301.
Veigaia decurtata ATHIAS-HENRIOT, 1961, Acarologia, 413-415, **new synonym.**

■ *Females* (from Kenya). Idiosoma pale, 370-395 μm long, anterior dorsal shield 225 μm, with 21 pairs of setae, posterior dorsal shield 145 μm, with 12 pairs of setae. Dorsal setae approximately equal in length, j1 34-37 μm, j3 (= i2) 33, z5 (=z3) 30, z6 29, r3 32 μm, distance j6-j6 56 μm. Venter as in fig. 18, sternal shield 120-128 μm long, st3-st3 63 μm, ventral shield 50 × 135 μm, VI 24 μm. Punctiform organ limited to two minute pores on isthmus between genital and ventral shields. Insemination apparatus barely visible (fig. 18). Lateral lobes of tectum transverse (fig. 19). Movable digit 100-107 μm, penultimate segment of chelicera 205-220 μm. Tarsus I 94, tarsus IV 125 μm long. Coxa IV with pore on anterior edge. Genu II without spine.

■ *Material examined.* Four ♀♀, soil under weeds at edge of pine forest, Mau Summit, Kenya. Two ♀♀, under *Cupressus*, 2750 m., one ♀, under tree heather, moorland, 3500 m., Aberdarer National Park, Kenya by W. BLOCK. Two ♀♀ Koa savannah and two ♀♀ Kipuka forest, Mauna Loa, Hawaii leg J. TENORIO.

■ *Remarks.* Relationships among the forms known as *V. agilis, exigua, pusilla* and *decurtata* are confusing. In 1916 BERLESE described *V. agilis* and *exigua* from moss from Vallombrosa, Italy and *V. pusilla* among dead leaves from " Columbia, N.A. ". All were described in the same paper. FARRIER (1957) pointed out the close similarity of these three forms and suggested that they might be synonymous. ATHIAS-HENRIOT (1961) added a fourth species, *V. decurtata* from Spain and Algeria, which she separated from *V. " exigua "* on the basis that in *decurtata* the lateral branches of the tectum are transverse,



FIGS. 18-19 : *Veigaia exigua* Berlese, ♀ from Kenya. 18) venter ; 19) tectum.

FIGS. 20-21 : *Veigaia exigua*, ♀ from Italy (drawn by FAUSTA PEGAZZANO). 20) tectum ; 21) venter, type ♀.

FIGS. 22-23 : *Veigaia pusilla* Berlese, ♀ from W. Va., U.S.A. 22) venter ; 23) tectum.

FIGS. 24-25 : *Veigaia agilis* Berlese, ♀ from U.S.A. 24) tectum ; 25) venter.

the " perforations " of the punctiform organ are on the genitoventral shield, and an " organ interne " is not present. BREGETOVA (1961) also described *V. exigua* ; she illustrated two forms of the tectum, one with the edges of the lateral lobes of the tectum acute and one with them transverse.

From published descriptions, observations of the types by Dr. FAUSTA PEGAZZANO, and examination of material from United States and Africa I have concluded that the above mites comprise three forms which are very similar in size and sclerotization, but which differ not only in the traits mentioned by ATHIAS-HENRIOT but also in the length of the chelicera and ventral shield (Table 2). Specimens from Kenya and Hawaii appear identical to ATHIAS-HENRIOT'S description of *V. decurtata* which is probably a synonym of *V. exigua* Berlese. BERLESE'S description of *V. exigua* does not clearly differentiate it from *pusilla* and *agilis* but Dr. FAUSTA PEGAZZANO has examined BERLESE's specimens of *V. exigua* (figs. 20-21) and observes that " the borders of the lateral lobes of the epistoma (tectum) are transverse (like fig. 2 in BREGETOVA). A spermatheca is not visible ". Length of the ventrianal shield in the type is 49 μm. Kenyan specimens and *V. decurtata* share these features. The known distribution of *V. exigua* then is Italy, Spain, Algeria, Russia, Kenya and Hawaii. LUNDQVIST (1974) reported *V. exigua* from mole nests in Sweden, but he may have had *V. agilis* which occurs in England.

TABLE 2. — Comparison of members of the *Veigaia exigua* complex.
The Measurements in parentheses are of type specimens.

Species	Known distribution	tectum lobe	sptheca	ventrianal length	moveable chela	fixed chela
exigua	Europe, Alg., Kenya, Hawaii	transverse	—	49-50 (49)	100-105 (90)	205-215
agilis	Europe, North America	acute	long	60-63 (60)	107-113 (104)	225-235
pusilla	North America	acute	sac	43-46 (45)	89-92 (92)	190-200

While comparing *Veigaia exigua* to related *Veigaia* from United States it became apparent that in United States two forms occur, sometimes together in the same locality. In both forms the lateral edges of the tectum are acute (figs. 23, 24). However, in one form a pair of conspicuous long tubules (spemathecae ?) is present (fig. 25), the ventral shield measures 60-63 μm long along the midline and the moveable digit is 107-113 μm long, whereas in the other form tubules are not present, the ventral shield is 42-46 μm long and the moveable digit is 88-92 μm long. Judging by Dr. FAUSTA PEGAZZANO'S descriptions and drawings of the types the mite with long tubules is clearly *V. agilis*, while the other mite is *V. pusilla*. Evidently BERLESE was correct in recognizing three species.

A puzzling feature of these mites is that although males are unknown in all three members of the *Veigaia exigua* complex, females of *V. pusilla* and *agilis* possess conspicuous structures which in *agilis* resemble the spermathecae of other mesostigmatid families (LEE, 1974). Does this mean that males really do occur and that the apparent spermathecae are used for storing sperm ? Special attempts to find males of *V. pusilla* and *agilis* by collecting from sites where this mite is plentiful have yielded only females. The presence of spermathecae in *V. pusilla* and *agilis* would not automatically mean that these mites reproduce sexually. Seminal receptacles are present in thelytokous females of the millipede, *Nemasoma varicorne* (ENGHOFF, 1976), but are reduced and variable compared to the bisexual form. ENGHOFF relates the variability of this organ to its lack of function in asexual females. However, the spermathecae of *V. pusilla* and *agilis* appear more elaborate than in many bisexual veigaiids. Spermathecae are not visible in *V. exigua* although spermathecal pores occur on coxa IV.

Veigaia planicola (Berlese)

Cyrtolaelaps nemorensis var. *planicola* BERLESE, 1892, Acari, Myriopoda et hucusque in Italia reperta.
Veigaia serrata WILLMANN, 1935, Bull. Mos. R. Hist. Nat. Belgique, 11 : 10-11.

Veigaia planicola is a distinctive mite easily recognized by its serrate fixed digit which has 15-20 small rounded teeth between two larger pointed ones and by the peculiar nature of the punctiform organ which usually consists of three pairs of platelets each bearing two pores. The only veigaiid at all similar to it is *V. sibirica* BREGETOVA.

V planicola is broadly distributed both geographically and ecologically. In the Palearctic region it has been reported from Italy, Germany, Belgium, the Balkans, England (cited from FARRIER, 1957), Sweden (LUNDQVIST, 1974), Crimea, Caucasus, Tian Shan (BREGETOVA, 1961), Spain, Balearics, Portugal and Algeria (ATHIAS-HENRIOT, 1961). In North America it has been found in Connecticut, Pennsylvania, Maryland, West Virginia, Ohio, Tennessee, Colorado and Quebec. FARRIER recorded it from India and it also occurs in Hawaii and Kenya. Several of the records from Europe are from caves. In West Virginia it has been found in leaf litter in a cave inhabited by pack rats and in forests and forest edges.

■ *Material examined.* Two ♀♀, soil under weeds at edge of pine forest, Mau Summit, Kenya. One ♀, one DN, under *Cupressus*, 2750 m., and one ♀, soil and litter under tree heather, moorland, 3500 m., Aberdares National Park, Kenya by W. BLOCK. Also one ♀ from Somerset, U.K., three ♀♀ ex Volcanoes National Park, Hawaii leg J. TENORIO and several ♀♀ from Connecticut, Pennsylvania, Maryland and West Virginia.

■ *Remarks.* Females from Kenya are indistinguishable from those from the United States. One of the specimens from Kenya has longer chelicerae than any other *V. planicola* I have examined, but each of the other three specimens from Kenya is within two standard deviations of the mean of West Virginia specimens in regard to measurements of the following ten characters : lengths of moveable and fixed digits of chelicera, tip to basal tooth of fixed digit, distance from tritosternum to sternal shield, st3-st3, and lengths of anterior dorsal shield, posterior dorsal shield, sternal shield, j1 and r3. Females from Kenya possess 18 or 19 small rounded teeth sandwiched between two larger pointed teeth on the fixed digit. This number ranges from 15 to 20 in specimens from West Virginia ; the number may differ even between left and right chelicerae of the same individual. Differences in sclerotization of the genitoventral area could not be detected. Thus by the morphological criteria used Kenyan and North American *V. planicola* are conspecific.

Veigaia uncata Farrier

Veigaia uncata FARRIER, 1957, N. Carolina Agr. Exp. Sta, Bul., 124 : 82-85.
Veigaia uncata BREGETOVA, 1961. Parasitol. sbornik Zool. Inst. Akad. nauk SSR, 20 ; 46-51.

The spurs on trochanter and femur IV are distinctive identifying characters of this large brown mite. Also both inner setae on the palp genu are spatulate, not forked. FARRIER (1957) described *V. uncata* from females collected in leaf mould from North Carolina and on orchid plants from Central America and Mexico. BREGETOVA (1961) found adult females and nymphs of *V. uncata* in large numbers associated with Magnolia at Batumi, Georgia, USSR and recorded it from Africa and Madagascar while BHATTACHARYYA (1972) collected it in a Botanical garden in India. I can find no difference between Tanzanian specimens and BREGETOVA's detailed illustrations. *V. uncata* is probably a synonym of *V. capreolus* which BERLESE (1905) described from Java. The distinctive ventral spurs on trochanter and femur IV are as in *V. uncata* and the size, color and dorsal chaetotaxy agree. BERLESE's figure of the tectum of *V. capreolus* also matches that of *V. uncata* as drawn by BREGETOVA and verbally des-

cribed by FARRIER. Without specimens or detailed illustrations of *capreolus*, however, I prefer to retain the name *uncata*.

V. uncata is the only *Veigaia* presently known to occur at lower elevations in Africa.

■ *Material examined.* About 70 ♀♀ and deutonymphs from the following habitats near Morogoro, Tanzania : duff under trees near Morogoro River, 550 m. ; dead leaves and grass stems under thicket below edge of rain forest, 1100 m. ; twigs and soil in lower part of rain forest near Morningside on Mt. Bondwa, 1500 m. Two ♀♀ from Mazumbai Natural Forest, near Lushoto, Tanzania by K. HOWELL.

GEOGRAPHIC DISTRIBUTION VEIGAIIDAE

The scarcity of veigaiids in east Africa is in marked contrast to the situation in Europe and eastern United States where *Veigaia* is often the commonest genus of mesostigmatid mite in forest soils. Only six species of veigaiids, three *Veigaia* and three *Gamasolaelaps*, are known from East Africa of which *Gamasolaelaps whartoni* and the three species of *Veigaia* are all very widespread geographically outside tropical Africa (see Table 3). For example, *G. whartoni*, one of the commonest mites in damp habitats in East Africa, has been found in Africa, southern United States, Japan and Georgian SSR, while *V. planicola* occurs throughout the Holarctic region as well as in Hawaii and Kenya. Only two veigaiids, *Gamasolaelaps cerviformis* and *G. bondwaensis*, are known to be restricted (= endemic) to tropical Africa. Both are montane. (Of course, the mesostigmatid fauna of much of Africa is entirely unknown.)

TABLE 3. — Known distribution of veigaiids occurring in East Africa. Altitudes refer to East Africa only.

Species	Males	Known geographic distribution	Altitude (Africa)
V. planicola	Absent	Eurasia, N. America, Kenya, Hawaii	over 2 700 m.
V. exigua	Absent	Europe, Kenya, Hawaii	over 2 700 m.
V. uncata	Absent	probably circumtropical ; also N. Carolina, Georgian SSR	up to 1 700 m.
G. whartoni	Absent	southern U.S., Japan, Georgian SSR, East Africa	up to 1 600 m.
G. cerviformis	Present	Ruwenzori, Aberdares, Mt. Kilimanjaro	2 100-3 500 m.
G. bondwaensis	Present	Uluguru Mts. (Tanzania)	2 100 m.

One can only speculate on the origins of the nonendemic veigaiids. The paucity of veigaiids in tropical Africa suggests that the nonendemic forms have been introduced. Soil mites are easily transported by man. For example, FARRIER (1957) has six separate records of females of *Veigaia uncata* intercepted on orchid plants in quarantine and European *Veigaia* have also been intercepted at U.S. ports. However, *V. uncata* and other nonendemic East African veigaiids sometimes occur in montane forests and moorland in localities little distributed by man ; this indicates they are not recent, weedlike introductions into Africa.

Comparison of distributions of unisexual and bisexual veigaiids.

It is noteworthy that the two veigaiids which are endemic to East Africa are bisexual whereas the four more broadly distributed forms are unisexual. Several authors (WHITE, 1973 ; CUELLAR, 1977 ; GLESENER and TILMAN, 1978) have noted that unisexual forms tend to occur at

higher latitudes, often in formerly glaciated regions, than their bisexual relatives. For example, in several species of the weevil genus *Otiorhynchus* a pathenogenetic race is widespread in glaciated areas of northern Europe while a bisexual race occurs only in unglaciated parts of the Alps (SUOMOLAINEN *et al.*, 1976). Many additional examples are listed by GLESENER and TILMAN. In Veigaiidae the pattern is similar in that unisexual forms are especially prevalent in northern regions whereas bisexual species predominate further south (HURLBUTT, 1979). (A possible exception is the bisexual *Gamasolaelaps excisus* which ranges from northcentral Siberia to Ireland, but males appear to be rare in this mite.) The reasons for the greater frequency of asexual forms at higher latitudes are not known, but GLESENER and TILMAN (1978) hypothesize that sexual forms tend to be favored in environments where biological interactions such as competition, predation and parasitism are important. Presumably biological interactions are more important in the tropics because of the greater species diversity and lesser temperature extremes characteristic of the tropics. GLESENER and TILMAN suggest that it is these biological interactions, especially the changing genotypes of other organisms, which generate the magnitude of environmental uncertainty favoring sexuality. While unisexual veigaiids are generally characteristic of high latitudes the distributions of *G. whartoni* and *V. uncata* are not noteworthy in that these mites mainly inhabit tropical and warm temperate areas. In mites unisexual forms seem to have broader ranges in terms of longitude as well as latitude (HURLBUTT, 1979). Bisexual races of *V. uncata* and *G. whartoni* have not been discovered.

GLESENER and TILMAN (1978) also note that asexual populations tend to occur at higher altitudes. This generalization is consistent with the observation that in many regions of the world mountains do have a poorer flora and fauna than lower altitudes (MACARTHUR, 1972), but in much of East Africa the continuously moist and richly vegetated mountains are probably more " biologically accommodated ", at least insofar as soil mites are concerned, than the surrounding seasonally seared savannah. (Of course, the flora and fauna become sparser again at very high elevations such as the alpine zone of Mt, Kilimanjaro.) Among East African veigaiids the two bisexual *Gamasolaelaps* are found at higher elevations than the unisexual member of the genus (Table 3). All three *Veigaia* are unisexual. *V. uncata* is circumtropical and occurs up to 1700 meters while each of the other two species of *Veigaia* (*exigua* and *planicola*) is known in East Africa from only a half dozen females collected above 3500 meters in such habitats as " edge of pine forest " and " moorland ". However, it should be pointed out that in Tanzania sites inhabited by the unisexual *G. whartoni* and *V. uncata* are by no means depauperate and contain at least as many species of mesostigmatid mites as occur in samples containing the bisexual *G. bondwaensis.*

Are the unisexual veigaiids from places as far apart as East Africa and United States really the same species ? Of course, if they reproduce only by thelytokous parthenogenesis there can be no interbreeding or gene exchange among different individuals so that the biological species concept is inapplicable. However, if the amount of morphological difference between African and American populations of unisexual veigaiids is no greater than that found within populations and if it is less than the minimum difference separating sympatric bisexual species, then it seems reasonable to regard the African and American mites as conspecific. In other words, two criteria are pertinent: 1) Are differences between populations from different regions greater than the variation within a population ? 2) Are these differences as great as those between definite sympatric species ? If the answer to question 1 is no, then the answer to question 2 should also be no. I do not have adequate material to compare allopatric *Veigaia uncata* or *exigua*, but samples of *Gamasolaelaps whartoni* from Tanzania and Florida do not differ significantly ($p > .05$) regarding mean lengths of any of the six characters compared (table 1). Variation within regions is much greater (at least 84 % of the sum of the variance components) than between regions for all six characters and using criteria suggested by MAYR (1969) the diffe-

rences between African American *G. whartoni* are far less than those used to separate subspecies even by " splitters ". Specimens of *Veigaia planicola* from Kenya and West Virginia also do not differ, at least not in the ten characters used for comparison. Therefore, African and American *G. whartoni* and *V. planicola* must be regarded as conspecific.

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