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EPIZOIC SYMBIOSIS: AN ORIBATID MITE, SYMBIORIBATES PAPUENSIS, REPRESENTING A NEW FAMILY, FROM CRYPTOGAMIC PLANTS GROWING ON BACKS OF PAPUAN WEEVILS (Acari: Cryptostigmata)[1]

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Abstract: An oribatid species of great interest was collected in New Guinea living on curculionid beetles bearing cryptogamic plants on their backs. The mite, *Symbioribates papuensis*, represents a new species, new genus and new family. Descriptions of the adult and immature stages are included. The new family may be classified in the superfamily Amerobothroidea, and a key to the families included is also presented.

Some interesting oribatid specimens were sent to me by Dr J. L. Gressitt (Bishop Museum, Honolulu) for identification. The mites live in plants growing on beetles in New Guinea. As I did not see them in their natural habitat, I would like to quote some ecological aspects of the mites and host-beetles from letters from Dr Gressitt: "We found an interesting situation in which apparently two species[2] of oribatid mites are living in fungi growing on the backs of large weevils in New Guinea. The hosts are several species, all new, of the genus *Gymnopholus*[3]. These mites live on and in a layer of fungi growing on the pronotum and elytra of these beetles. The beetles are phytophagous and live on leaves of woody plants in the high altitude moss forests. In addition to the fungi, we have found other plants growing on the same beetles" (from his letters of 13 and 29 July 1965). Moreover, Mr W. J. Voss (Bishop Museum) stated in his letter (23 July 1965) "Oribatids were taken from lichens growing on the backs of some beetles (Curculionidae) from New Guinea." The host-beetles, representing a new species, are described by Dr Gressitt (p. 221) in this present issue. At any rate, such as unusal relationship has never been observed in oribatid mites and aroused great interest. The mite in question possesses also many unique morphological characters and is described as a new species belonging to a new genus representing a new family.

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1. Based on material resulting from work on National Science Foundation grants (GB-518, 3245) to Bishop Museum.
2. Result of my examination has revealed that they consist of a single species containing adult as well as immature forms.
3. See preceding paper by Gressitt, pp. 221.

Genus **Symbioribates** Aoki, n. gen.

Prodorsal/notogastral separation completed in the stages previous to tritonymphs, discernible in the middle part and extinct on both sides in tritonymphs, and widely interrupted in the middle part (best to say almost absent) in adults. Interlamellar setae well developed. Sensillus clavate in immature stages and almost spherical in adults. Bothridium, and also sometimes sensillus, of adults covered by a roof-like expansion of notogaster on each side. Twelve pairs of notogastral setae are found in tritonymphs, and 10 pairs in adults. Four or five pairs of distinct areae porosae developed in adults. There are 1 pair of anal setae in adults and 3 pairs in tritonymphs. Genital aperture of adults provided with 4 pairs of setae, whereas that of tritonymphs without setae. Aggenital setae absent. Adult forms exhibit a marked sexual dimorphism, especially in the shape of prodorsal setae as well as in size of areae porosae on notogaster. Terrestrial animals.

Type-species: *Symbioribates papuensis* n. sp.

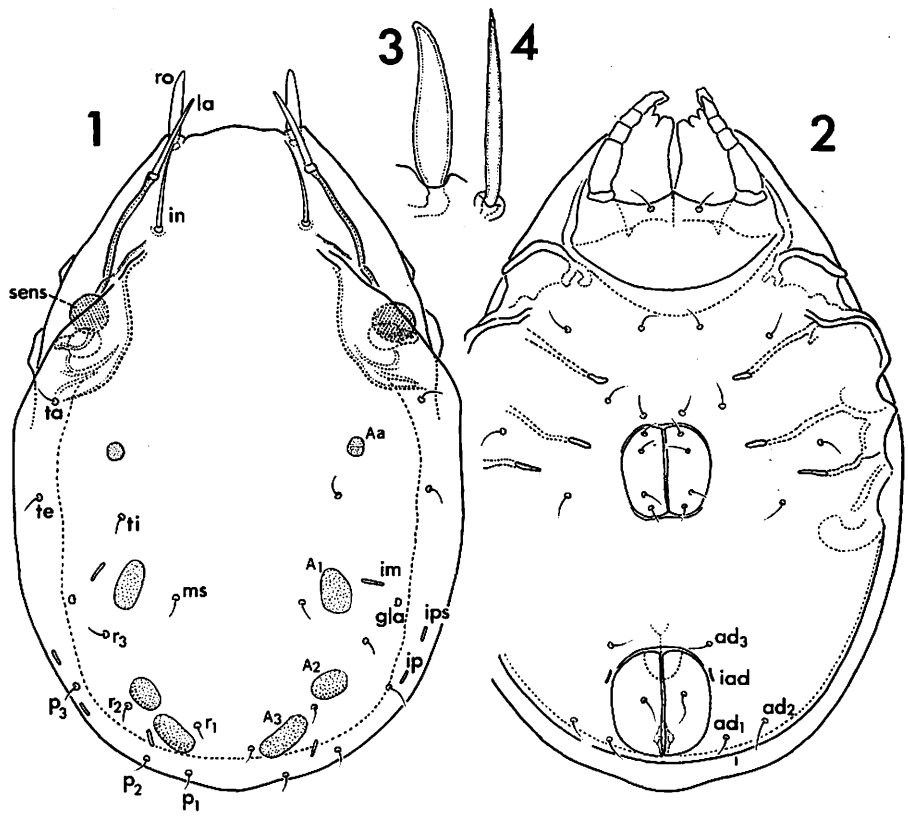
Symbioribates papuensis Aoki, n. sp. Figs. 1-13.

MATERIAL EXAMINED: Holotype ♂ (BISHOP 6845), Bome, 1950 m, Goilala, Owen Stanley Range, SE New Guinea, 16-31.III.1958, ex fungi with algae growing on curculionid beetle, *Gymnopholus algifer* Gressitt, taken by W. W. Brandt; 7 paratopotypes (2♂♂, 5♀♀), same data; 10 paratypes (2♂♂, 1♀, 6 tritonymphs, 1 deutonymph ?), same data except 24.II-7. III.1958. Additional paratypes from Mt Kaindi, NE New Guinea (2300 m; VII. 1965, J. Sedlacek), on *Gymnopholus lichenifer* Gressitt, and from Bulldog Road (2800 m; Sedlacek) on *G. acarifer* Gressitt; many additional specimens left in situ on the weevils. Holotype and 14 paratypes (4♂♂, 5♀♀, 6 nymphs) in Bishop Museum, Honolulu; 3 papatypes (1♂, 1♀ and 1 nymph) in National Science Museum, Tokyo. Additional paratypes to be distributed.

♂ (figs 1-4, 6-10). Measurements: Length, 235-242 μ; width, 164-165 μ (in 3 measurable specimens).

Prodorsum: Broad, with slightly convex lateral margins and with a truncate anterior margin. The latter provided with 2 minute teeth on the middle part as well as on each side when the mites observed in crushed specimens. Rostral, lamellar and interlamellar setae greatly differ from one another; rostral setae (25-27 μ) extraordinarily thick and blunt at tip, being parallel to each other and slightly bent ventrad (fig 3); basal portion of setae covered by a dorsal extensions of rostrum. Lamellar setae (29-30 μ) strong, but far thinner than rostrals, rather blunt at tip, being inserted each on a small apophyse and slightly bending inward and convergent. Interlamellar setae (40-47 μ) distinctly longer and thinner than lamellars, terminating in a fine, flagelliform tip. A lamellar ridge (costula) reaching anteriorly the insertion for lamellar seta on each side. A weak line arising from basal portion of ridge and almost reaching insertion for interlamellar seta on each side. Bothridium completely and sensillus completely or partly covered by a roof-like extension of notogaster. Sensillus spherical with a peduncle thin and sigmoid; surface structure of sensillar head minutely roughened. Round opening of bothridium directed dorsad, with diameter smaller than that of sensillar head; basal portion of bothridium bending outward, i. e. directed laterad. Surface of prodorsum nearly smooth.

Notogaster: The greatest width occurs rather in anterior portion where lateral margin



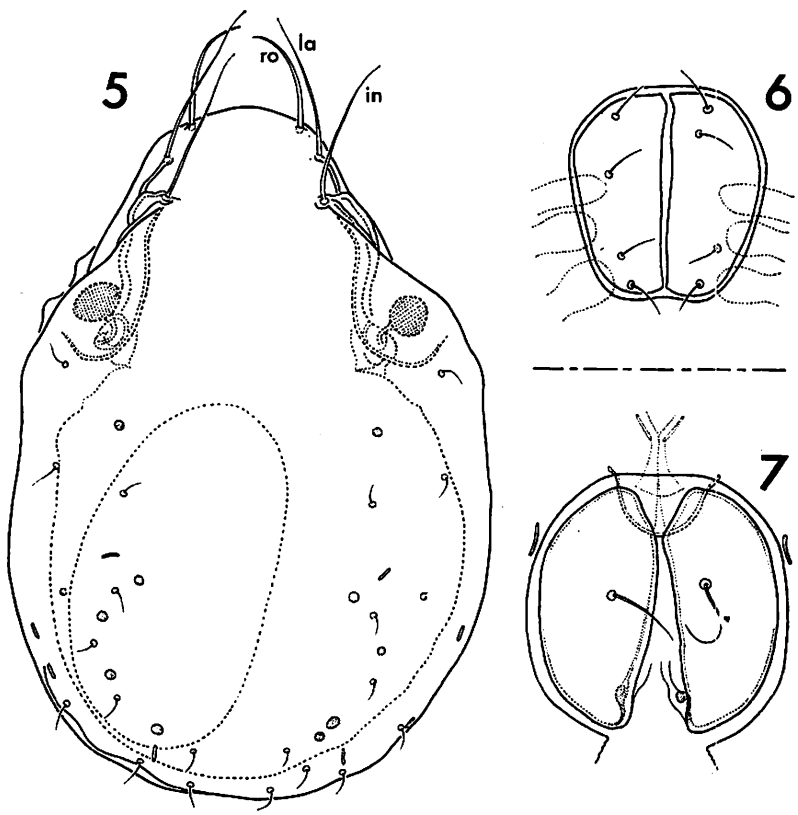
Figs. 1–4. *Symbioribates papuensis* n. sp., ♂. 1, dorsal view; 2, ventral view; 3, rostral seta; 4, lamellar seta.

forms a weak angulation on each side. Posterior margin shows a weak tendency to undulation. Anterior border of notogaster widely extinguished, so that prodorsum and notogaster smoothly fused in the middle part between insertions for interlamellar setae. A marked roof-like expansion exists anterolaterally on each side, completely covering bothridium; inner border of it observed far inside the outline of notogaster and indicated in fig 1 with double dotted line. There are 10 pairs of minute notogastral setae arranged as in fig 1. Although their insertions are easily recognizable as clear pale-colored spots, the setae are so fine and hard to see. Four pairs of areae porosae arranged in usual positions. Among them, A_1, A_2 and A_3 conspicuously large in size. Four pairs of lyrifissures present. They are relatively long and distinct. Their arrangement rather variable, especially in the case of *ih* and *ips*. Opening for latero-abdominal gland small-sized and situated posterolateral to *im*. Surface of notogaster minutely pitted.

Anogenital region (figs 2, 6 & 7): Anal aperture smoothly rounded in outline, a little longer than wide. Each anal plate provided with only 1 fine seta which is inserted a little anterior to the mid-distance along plate. Near posterior end of each anal plate is a rounded node-like thickening. This is not an external structure and is apparently different

from a pore for setal insertion. A pair of round structures which were drawn by Wallwork (1963) in his fig 23 (p. 739) of *Halozetes intermedius* appear to be the same structure as mentioned above. Praeanal plate markedly developed, almost semicircular and movably hinged at anterior margin of anal opening. A pair of long adanal fissures situated close to lateral margins of anal aperture, being aligned longitudinally and somewhat bent. Three pairs of thin adanal setae present; ad_1 and ad_2 inserted close to posterior margin of ventral plate, while ad_3 situated a little anterior to anterior margin of anal aperture; their mutual distance about as wide as anal opening; all adanal setae similar in length as well as in shape to one another. Interspace between anal and genital apertures equal or a little longer than anal aperture. Genital aperture as long as wide or somewhat longer than wide. The largest width occurs rather anteriorly. Each genital plate provided with 4 fine setae; they are arranged rather irregularly, but distance between g_2-g_3 seems to always be the largest. No structures such as aggenital fissures discernible. Aggenital setae absent.

Epimeral region: Apodemata II, SJ and III developed as short ridges, among which *apo. 3* the longest. Epimerata I, II, III and IV on each side bearing 2, 2, 1 and 1 epimeral



Figs. 5-7. *Symbioribates papuensis* n. sp. 5, dorsal view of ♀; 6, genital aperture of ♂; 7, anal aperture of ♂.

Table. 1. Number of setae on each segment of each leg. t: a total number of setae; (s): number of solenidia; (f): number of famulus.

	Tr	Fe	Ge		Ti		Ta		
	t	t	t	(s)	t	(s)	t	(s)	(f)
I	1	4	3	(1)	5	(2)	14	(2)	(0)
II	1	5	3	(1)	3	(1)	11	(2)	(0)
III	2	3	1	(0)	4	(1)	8	(0)	(0)
IV	1	2	1	(0)	3	(1)	9	(0)	(0)

setae, respectively. A strong curved ridges found anterior to insertion for leg I and II, respectively.

Gnathosoma (fig 10): Camerostome somewhat wider than long. Labiogenal articulation discernible. A pair of setae *h* inserted on anterior part of mentum. Genae shows 2 segment-like lines on lateral half. Setae *a*, *m* and *h* sharply pointed at tip. Palp 5-segmented. Palpal tarsus somewhat widened anteriorly. Setal formula: (0-2-1-2-7?). Chelicera of normal shape, being provided with 2 setae.

Legs: Each leg has strongly swollen femur, shortened tarsus, and 1 strong claw. The setal formula of each leg is shown in Table 1. Tarsus I lacking in *a* and one of *pv*; ω_1 and ω_2 very long, flagelliform, and with a curled tip. Tarsus II lacking in *it*, *a* and *pv*; ω_1 and ω_2 similar to those of tarsus I. Tarsus III lacking in *it*, *a*, *pv* and one of *ft*. Tarsus IV lacking in *it*, *a*, one of *pv* and one of *ft*; exceptionally, *pv* are completely absent in a single specimen. It is of interest to note that femur II possesses 5 setae. Trochantera III and IV strongly swollen, of which the former is provided with 2 setae.

♀ (fig 5). Measurement: Length: 242-250 μ; width: 168-170 μ (in 3 measurable specimens).

The species exhibits a distinct sexual dimorphism. The differences distinguishing ♀♀ from ♂♂ are summarized as follows:

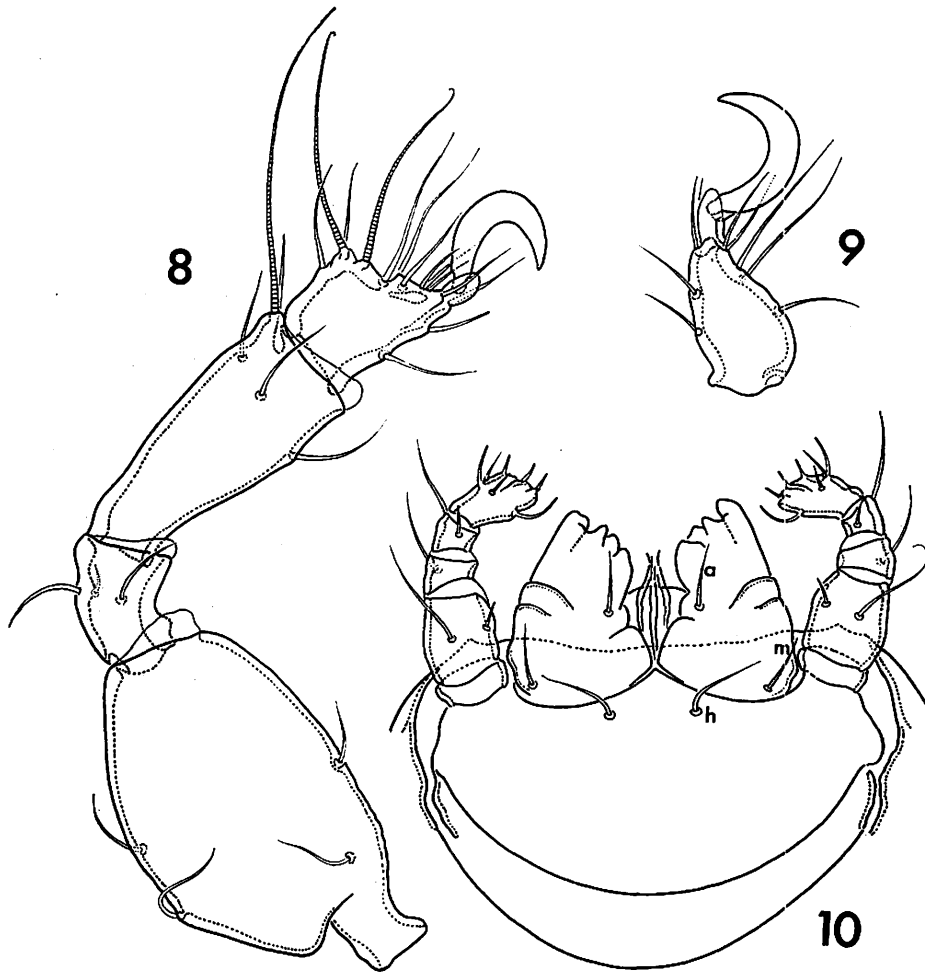
1) Rostral, lamellar and interlamellar setae similar in thickness to one another. All these setae with a fine flagelliform tip. Length: *ro* (40-45 μ), *la* (40-62 μ), *in* (43-58 μ); each of them longer than the corresponding seta of ♂.

2) Areae porosae on notogaster distinctly smaller than those of ♂. Their number varies from 8 to 10, i. e. 1 or 2 additional ones often observed; the examined ♀♀ show the following number of areae porosae (left-right): 5-5 (fig 5), 5-5, 4-5, and 4-4. Their arrangement is also variable; in the case 5 areae porosae exist on one side of notogaster, 2 of them are usually situated very close to each other, sometimes almost touching each other.

3) Genital aperture a little larger than that of ♂, whereas anal apertures of both sexes nearly equal in size. Interspace between anal and genital apertures generally slightly longer than of ♂, but 1 ♀ showed the interspace distinctly shorter than that of any ♂.

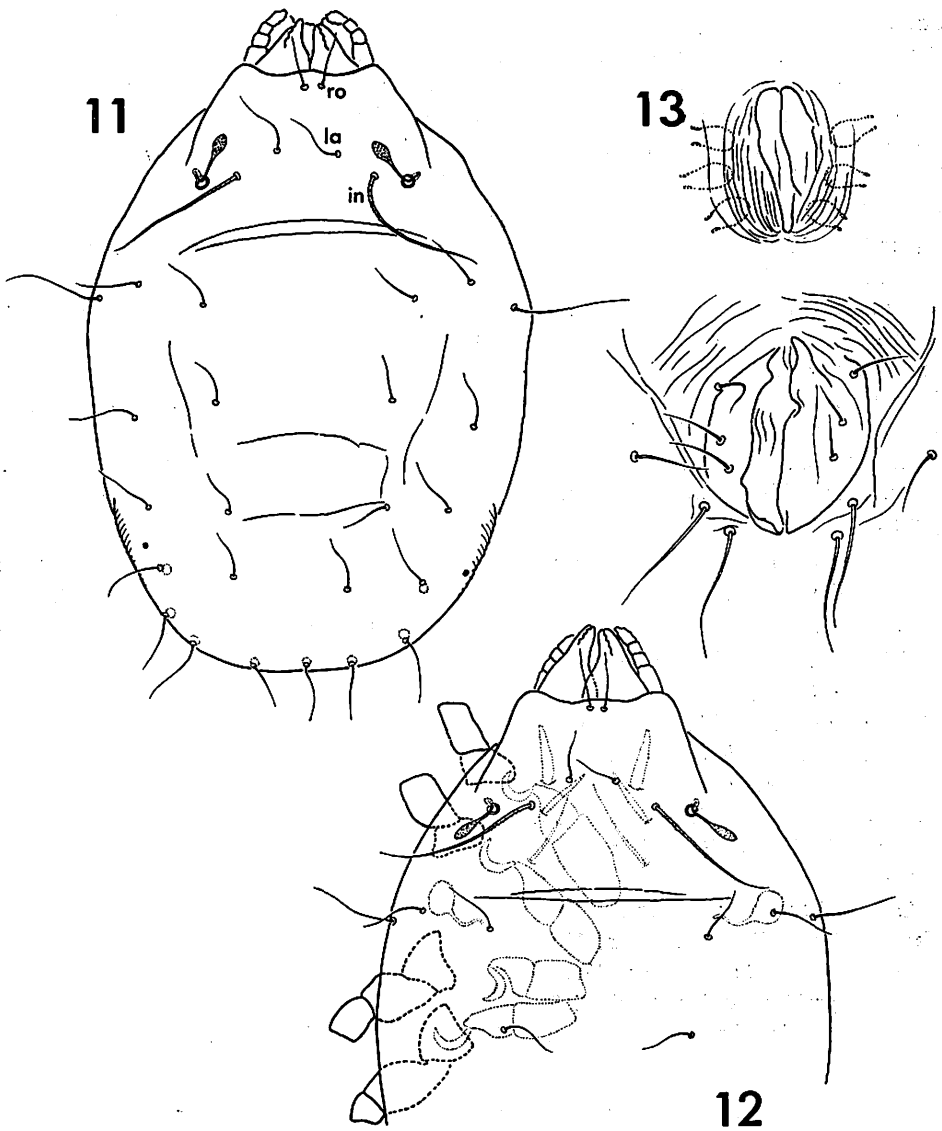
4) Body size of ♀ generally slightly larger than that of ♂. But 1♂ was exceptionally larger than any ♀ examined.

A ridge reaching insertion for interlamellar seta on each side (fig 5) has been drawn as stronger than that of ♂ (fig 1); such a tendency was actually observed, but it should better be considered as an individual variation. No other difference was discovered between ♂♂ and ♀♀.



Figs. 8-10. *Symbioribates papuensis* n. sp., ♂. 8, leg I (antiaxial); 9, tarsus IV (antiaxial); 10, ventral view of gnathosoma.

Tritonymph (figs 11-13). Porose hysterosomal sclerites absent. Rostrum separated from remaining part of prodorsum by a lateral border on each side. Anterior margin of rostrum undulating and concave. Rostal setae thin and with a flagelliform tip, inserted close to each other near anterior margin of rostrum. Lamellar setae similar in length and in shape to rostrals; their mutual distance distinctly longer than that of rostral setae. Interlamellar setae distinctly thicker and longer than former, being minutely roughened and relatively dark in color; their mutual distance more than 2× as long as that of lamellar setae. Sensillus clavate, with a head densely and minutely rounghened. Faint, double line separating prodorsum and notogaster in the middle part, but being extinguished on both sides. On notogaster, 12 pairs of thin setae present, of which anterolateral pair of setae longest. A tendency to transverse wrinkling near lateroposterior portion on each side. On middle part



Figs. 11–13. *Symbioribates papuensis* n. sp., tritonymph. 11, dorsal view; 12, tritonymph containing a developing adult form which will be a ♂; 13, anogenital region.

of notogaster some faint, irregular lines discernible. A pair of round orifices lateroposteriorly, perhaps representing openings for latero-abdominal glands. Genital aperture exhibits a lot of longitudinal wrinkles; genital setae absent. Anal aperture provided with 3 pairs of anal setae. There are 3 pairs of adanal setae, among which ad_1 and ad_2 longer and thicker than ad_3. Palp 5-segmented. Adult forms (1♂ and 1♀) are already developed in 2 of 6 tritonymphs examined, respectively. One of them containing ♂ form in it is shown in fig 12.

Deutonymph (?). A single specimen of 7 nymphs collected undoubtedly differs from the rest (tritonymphs) in the small size and some other structures. It is, however, uncertain whether it represents deutonymph or protonymph. The separation between prodorsum and notogaster is indicated by a straight, complete line. Sensillus clavate, but somewhat more slender than those of tritonymphs. Arrangement of rostral, lameller and interlamellar setae similar to that of tritonymph. Rostral setae flagelliform; lameller as well as interlamellar setae are unfortunately lost. Genital as well as anal aperture seems to have no setae.

Systematic position of the genus Symbioribates The genus *Symbioribates* is very unique not only morphologically, but also ecologically. Above all, special attention should be paid to the presence of only a single pair of anal setae, the sexual dimorphism affecting prodorsal setae and areae porosae, and the status of living on beetles. It is highly interesting that the mites were collected high in the mountains (1950-2500 m above sea level) because members of related families usually live in tidal zones or not far from the sea. Classifying the genus within the superfamily Ameronothroidea does not seem to be unreasonable, but it is quite difficult to place the genus in any of the known families of the superfamily, *i. e.* Ameronothridae, Podacaridae and Fortuyniidae. I prefer to set up a new family for the genus.

The genera belonging to the superfamily Ameronothridae have been studied and discussed by Dalenius & Wilson (1958), Hammen (1960, 1963), and Wallwork (1962, 1962a, 1963, and 1964). The results of these works are summarized in the following list and key together with Symbioribatidae newly established.

Superfamily Ameronothroidea Balogh, 1961
- Family Ameronothridae Willmann, 1931
  - Genus *Ameronothrus* Berlese, 1896
  - Genus *Hygroribates* Jacot, 1934
- Family Podacaridae Grandjean, 1955
  - Genus *Podacarus* Grandjean, 1955
  - Genus *Halozetes* Berlese, 1917
  - Genus *Alaskozetes* Hammer, 1955
- Family Fortuyniidae Hammen, 1963
  - Genus *Fortuynia* Hammen, 1960
- Family Symbioribatidae Aoki, n. fam.
  - Genus *Symbioribates* Aoki, n. gen. (The type-genus of the family)

Key to the families of the superfamily Ameronothroidea

1. Anal aperture with 2 pairs of setae; aggenital setae present; genital aperture with 5 or 6 pairs of setae; 14 or 15 pairs of notogastral setae present; areae porosae absent on notogaster. Marine or terrestrial, but as a rule not far from the sea..... 2
   Anal aperture with 1 pair of setae; aggenital setae absent; genital aperture with 4 pairs of setae; 10 pairs of notogastral setae present; areae porosae present on notogaster; interlamellar setae and sensilli well developed; prodorsal/notogastral separation incomplete, widely interrupted in the middle part. Immature stages without notogastral porose sclerites. Terrestrial animals ..... **Symbioribatidae**, n. fam.
2. Light spot on the anterior part of notogaster absent; interlamellar setae well devel-

oped; aggenital neotrichy sometimes present. Immature stages with notogastral porose sclerites. Prodorsal/notogastral separation complete or incomplete in adults; genital aperture with 6 pairs of setae..... **Podacaridae**

Light spot on the anterior part of notogaster present; interlamellar setae extremely small or absent; aggenital neotrichy absent. Immature stages without notogastral porose sclerites 3

3. Prodorsal/notogastral separation complete; pedotecta I and II present; setae *it* on leg IV absent; genital aperture with 5 pairs of setae; labiogenal articulation complete; bothridia and sensilli present. Marine animals ..... **Fortuyniidae**

Prodorsal/notogastral separation incomplete; pedotecta I and II absent; setae *it* on leg IV present; genital aperture with 5 or 6 pairs of setae; labiogenal articulation incomplete; bothridia and sensilli present or absent. Marine or terrestrial animals ..... **Ameronothridae**

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