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Imparipes (*Sporichneuthes* nov. subgen.), a remarkable new taxon in the mite family Scutacaridae (Acari, Heterostigmata)

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Abstract: The new subgenus *Imparipes* (*Sporichneuthes*) is established. The species *I. intermedius* PAOLI, 1911, *I. kaszabi* MAHUNKA, 1967 and *I. aricus* MAHUNKA, 1971 that belong to the new subgenus, are discussed in regard to their morphological characteristics. A redescription of *Imparipes* (*Sporichneuthes*) *dispar* Rack, 1964 and the description of *I.* (*Sporichneuthes*) *schusteri* nov. spec. are presented. *Imparipes humilis* DELFINADO, BAKER & ABBATIELLO, 1976 is a new synonym of *Imparipes dispar* RACK, 1964. The currently known distribution of the new subgenus including new localities is given.

Introduction

The genus *Imparipes* BERLESE, 1903 is divided into the three subgenera *Imparipes* s. str. PAOLI, 1911, *Parimpipes* MAHUNKA, 1975 and *Telodispus* KARAFIAT, 1959 and includes some 160 described species. *Imparipes* species are known for all continents except Antarctica. The worldwide distribution and the relatively large number of species should not, however, disguise the unsatisfactory state of taxonomy for the genus (EBERMANN 1988). Morphological analysis of some previously known species of *Imparipes* revealed morphological characteristics that had been undetected and required the creation of a new subgenus.

Results

Taxonomy

Abbreviations: ap = apodeme; astpl = anterior sternal plate (= ventral propodosoma); ch1 and ch2 = cheliceral setae; fe = femoral setae of gnathosoma; Fe = femur; FG = palpal femorogeno; fo = foramen (circumgnathosomal foramen sensu CROSS 1965; used to incorporate the hypognathic gnathosoma); ge = genual setae of gnathosoma; Ge = genu; Gn = gnathosoma; le = cuticular ridge in the area of ap1 or the insertion sites of 1a; lTa = length of tarsus; lPrTa = length of pretarsus; lTr = length of trochanter; ped = pedipalpus; pp = palpcoxal setae; pstpl = posterior sternal plate; PrTa = pretarsus; s = standard deviation; se = setigenous accessory structure (sensu LINDQUIST 1986); spou

= spout-like formation of the foramen between the insertion points of 1a; sol = solenidion; solTi = tibial solenidion; solTa = tarsal solenidion; solTiTa = tibiotarsal solenidia; st = stigma ; su = subcapitular setae of gnathosoma; Ta = tarsus; Ti = tibia; TiTa = tibiotarsus; Tr = trochanter; wastpl = width of anterior sternal plate; wpstpl = width of posterior sternal plate; wGn = width of gnathosoma; x = average value; ≅ = about the same length; < = shorter than; > = longer than.

Museums and other institutions: Coll. BERL. = Berlese Acaroteca, Istituto Sperimentale di Zoologia Agraria, Florence (Italy); HNHM = Hungarian Natural History Museum Budapest (Hungary); NYSTM = New York State Museum, Albany (N.Y., USA); USDA = United States Department of Agriculture, Beltsville (Maryland, USA); ZMH = Zoologisches Institut und Zoologisches Museum, University of Hamburg (Germany).

Nomenclature: Notation of the body setae is modified after LINDQUIST (1977) and that of the gnathosoma follows LINDQUIST (1986).

Body dimensions: For the width of the anterior sternal plate, the distance between the insertions of setae 1b was taken; the width of the posterior sternal plate is the distance between the insertions of setae 3c.

The number of the solenidia is given in parenthesis with the description of the extremities. All the measurements in this paper are given in µm.

Imparipes BERLESE, 1903

Sporichneuthes subgen. nov.

Type species: *Imparipes* (*Imparipes*) *histricinus dispar* RACK, 1964 (Loc. typ.: Hamburg, Coll.: Zool. Inst. and Zool. Mus., University of Hamburg).

Diagnosis (female): Gnathosoma capsule extremely broad and long and in the folded state it appears to be about as wide as it is long. The median length of the anterior sternal plate (ventral propodosoma) is shorted. The relation of the width of the anterior sternal plate (measured just next to setae 1b) : width of gnathosoma capsule is always more than 1 : 0.5; frontally and between the pedipalps the gnathosoma capsule has a funnel-like depression. The femorogenu of the pedipalps are free and face each other horizontally. Setae ch2 of the gnathosoma s-shaped; setae dFe and dGe of the gnathosoma are oriented horizontally, the subcapitular setae are unusually long and always extend beyond the anterior edge of the gnathosoma. The circumgnathosomal foramen between the insertions of setae1a with a spout-like formation through which the setae su pass when the gnathosoma capsule is folded back. Stigma open-

ings shifted dorsolaterally. Middle part of the pharyngeal pump well developed, the anterior and posterior segments are reduced.

The characteristics in Table 1 and Fig. 1a, 1b and 11 refer to the characteristic differences between the subgenera *Imparipes* s.str. and *Sporichneuthes*.

subgenus *IMPARIPES*	subgenus *SPORICHNEUTHES*
1. Gnathosoma (Gn) narrow	Gnathosoma (Gn) very wide
2. Relation wGn:wastpl = below to max. 1 : 0.5	Relation wGn:wastpl = always distinctly higher than 1 : 0.5
3. Gn frontal between the pedipalps slightly vaulted outward	Gn frontal with funnel-like depression between the pedipalps
4. FG of ped flap-like, wide and overlapping when Gnathosoma is folded back	FG piston-like, opposed and not overlapping when Gnathosoma is folded back
5. Palpalsetae dFe and dGe face caudad	Palpalsetae dFe and dGe face mediad
6. Subcapitular Setae su short, do not reach the anterior end of the gnathosoma	Subcapitular setae very long, always extend beyond the anterior end of the gnathosoma
7. ap1 median "normal"	ap1 median spout-like
8. Stigmata open frontally	Stigmata open dorsolaterally
9. Pharyngeal pump has 3 parts	Pharyngeal pump has 3 parts but the anterior and posterior sections are very reduced

Tab.1: Differences in morphological characteristics of the subgenera *Imparipes* and *Sporichneuthes* subgen. nov.

Note: The frontal depression in the gnathosoma capsule can only be seen in SEM preparations. The characteristic orientation of the gnathosomal setae ch1, dFe and dGe (Fig. 1, 3) that is also visible on the holotype can usually only been seen in material in ethanol or in SEM images; on mounted specimens these setae are usually pressed out of their normal position by the cover glass.

Derivation of name: sporos (gr. spore), ichneuthes (gr. seeker) = spore seeker. The name refers to the conidiospores of the fungi that these mites feed on. Newly discovered feeding behaviour will be reported in detail elsewhere (paper in prep.).

Species of the new subgenus *Sporichneuthes*

The following species were placed in the new subgenus *Sporichneuthes*; the reasons for doing so will be given in the following:

Imparipes (Imparipes) dispar RACK, 1964

Imparipes (Imparipes) humilis DELFINADO, BAKER & ABBATIELLO, 1976

Imparipes (Imparipes) intermedius PAOLI, 1911

Imparipes (Imparipes) kaszabi MAHUNKA, 1967

Imparipes (Imparipes) aricus MAHUNKA, 1971

Imparipes schusteri **nov. spec.**

Imparipes (Sporichneuthes) dispar RACK, 1964

1964 *Imparipes (Imparipes) hystricinus* BERLESE, 1903 ssp. *dispar* RACK: 188 - 189

1995 *Imparipes (Imparipes) dispar*: EBERMANN 1995

REDESCRIPTION (female)

Material examined

Holotype female as well as 15 paratypes (ZMH), 3 paratypes (HNHM), Hamburg-Langenhorn, 21.8.1957, leg. H. J. HASS; further material (ZMH) from the same site. Additionally, several hundred specimens from the Austrian locality Haselsdorf (see list of localities) including a large number from laboratory breeding).

Body dimensions

wastpl: Material from Hamburg: 40 - 47, x = 44 (n = 20), s = 1.63 (Holotype 47); material from Haselsdorf: 38 - 49, x = 44 (n = 20), s = 3.87;

wpstpl: Hamburg: 68 77, x = 72 (n = 20), s = 1.98 (Holotype 73), Haselsdorf: 60 - 84, x = 74 (n = 20), s = 4.75;

wGn: Hamburg: 25 30, x = 28 (n = 20), s = 1.25 (Holotype 28), Haselsdorf: 25 - 31, x = 29 (n = 20), s = 1.64.

The entire surface of the body stippled with fine pores. Tergit C large and covers more than half of the dorsal surface; its free edge with fine radial stripes (not shown in Fig. 2). Cupulae 1a and 1h oval.

Dorsum (Fig. 2): The length of all the dorsal setae varies and this variability is evident when the body halves of one individual or several individuals

are compared, regardless of their origin. Length c1 ≅ c2 or c1 > c2 or c1 < c2, there are also differences in thickness, see holotype; length d ≅ f or d < f or d > f; f > h1; e < h2 or e ≅ h2; all setae in the c-series barbed; d, e, f, h1 and h2 strong and sparsely barbed.

Venter (Fig. 3): ap1 and ap2 well developed, ap3 present,weakly sclerotized, ap4 reaches half the width of the posterior sternal plate, ap5 highly sclerotized, median incomplete; length of ventral setae varies, i.e. identical setae on the left and right sides of the body sometimes differ considerably in length; 1a inserts on the border (le), le usually ends on the insertion point of 1a and very rarely extends beyond that medially (Fig. 12a); distance 1a - 1a > 1a - 1b, 1a about as long as 1b; 2b distinctly longer, extends beyond the insertion of 3b, 2b dagger-shaped with occasional barbs; length 3a < 3b, 3b ≅ 3c; 4a located anterior to and within insertion of 4b, 4b inserts slightly posterior to ap5, 4a < 4b, 4c somewhat longer than 4b; length ps1 > ps2 < ps3, ps1 and ps3 barbed, ps2 smooth or with occasional barbs, ps2 is less than half the length of ps1.

Gnathosoma (Fig. 3, 11b): Relation wastpl wGn = 1 0.56 - 0.67, holotype 1 : 0.58; x = 1 : 0.62 (n = 40), s = 2.77; when the gnathosoma is folded back the setae su do not reach ap2; for pharyngeal pump see Fig. 11b, two hooklets on the proximal pharyngeal canal (Fig. 11b, arrow).

Trichobothrium (Fig. 4a): Club-shaped, thin stemmed, distal with scales, v1 > v2.

Leg I (Fig. 4b): Setal formula: Tr 1, Fe 3, Ge 4, TiTa 16 (4sol); TiTa slender, claw with thin, elongated, laterally twisted tip; length of sol ω2 = ω1 = φ2 < φ1, ω1 thicker than ω2, distal pointed tip, φ2 thin stemmed, distally club-shaped and thickened, pointed tip, φ1 like ω2, but longer.

Leg II (Fig. 4c): Setal formula: Tr 1, Fe 3, Ge 3, Ti 4 (1sol), Ta 6 (1sol); solTi small, solTa twice as long, distal pointed tip, Ta with 2 very bent claws and empodium.

Leg III (Fig. 4d): Setal formula: Tr 1, Fe 2, Ge 2, Ti 4 (1sol), Ta 6; solTi very small, Ta with 2 claws and empodium.

Leg IV (Fig. 4e): Setal formula: Tr 1, Fe 2, Ge 1, Ti 3 (1sol), Ta 5; relation lTr : lTa = 1 : 0.65 - 0.74, holotype 1 : 0.74, x = 1 : 0.68 (n = 20), s = 2.59; lTa lPrTa (without empodium) = 1 0.69 - 0.88, holotype 1 : 0.79, x = 1 0.79 (n = 20), s = 4.28; PrTa with tiny claws, empodium elongated and slender. Setae dF > v'Ti, dTi and tc' approximately equally long, dTi thins out distally, but has a blunt end, tc' thins out distally with a fine, sharp end; length pv" variable: Reaches the empodium or extends beyond it, sometimes consid-

erably (holotype), u' inserts just distal to pv', u' is the shortest tarsal seta; solTi dorsal from v'Ti, minute.

Males and larvae: Already known from laboratory breeding; their first description will follow elsewhere (paper in prep).

Differentiation from other species of the subgenus

Imparipes dispar differs from the other species in the subgenus with solenidia ω2 and φ1 (leg I) of nearly equal length, and two hooklets on the proximal pharyngeal canal; *I. dispar* generally resembles *I. intermedius* and 1e is very similar but except for those characteristics, *dispar* can be differentiated from *I. intermedius* by further characteristics, i.e. a generally more slender gnathosoma, a distinctly greater distance between 4a - 4b, through dF > v"Ti (IV) and a generally longer pretarsus IV. *Dispar* differs from *I. kaszabi* mainly with the differing structure of 1e, differing position of 4a - 4b, the presence of a claw on TiTa (I), through dF > v"Ti (IV), blunt tip of seta dTi (IV) and a generally longer pretarsus IV. Further, *dispar* differs from *I. aricus* through the different structure of 1e, different positions of 4a - 4b and the different tips of seta dTi (IV), and from *I. schusteri* nov. spec. through relatively longer dorsal setae, the considerably shorter setae su, in the structure of ap5, in the greater distance from 1a - 1a as compared to 1a - 1b and in a different position of 4a - 4b. Table 2 shows a comparative survey of species - typical characteristics with the exception of structure of 1e and the position of 4a - 4b.

Note: *Imparipes* was described by RACK (1964) as a subspecies of *Imparipes hystricinus* BERLESE 1903. *Dispar*, however, differs considerably from *Imparipes histricinus* ("*histricinus*" is the correct spelling, see MAHUNKA 1980), especially in the area of the gnathosoma, so that a conspecificity between *histricinus* and *dispar* can be ruled out (Fig. 1, 11). This circumstance was taken into account in an earlier publication and the new name combination *Imparipes dispar* RACK, 1964 was introduced, but without an explanation (EBERMANN 1995). This will be provided here ex post-facto in a redescription of *dispar*.

Some characteristics that are typical for the subgenus, such as the gnathosoma, the spout on median ap2 and the position of the stigmata that were not mentioned in the original description. The original description also differs from the actual situation in two other respects: 1) Setae d are designated by RACK as the longest dorsal setae and the difference in length to f ("Setae lumbales internae") is given as 3 µm. This does not agree with Fig. 2 of the original description, in which the difference in length is shown to be much greater. An animal with a length ratio from d to f as given in that figure could not be

found among the specimens. 2) The illustration of Ta IV shows only 4 of the 5 setae that are actually present. The very short seta u' that is usually covered by seta pv' and thus easily overlooked, is missing.

Author's specimens: Hundred of females from the the locality Haselsdorf (Austria) as well as extensive, uncounted material from 5 years of laboratory breeding that began with animals from the Haselsdorf site. Reference slides have been deposited in the ZMH and HNMH and the author retains further reference slides and specimens in ethanol in his own collection.

Imparipes (Imparipes) humilis DELFINADO, BAKER & ABBATIELLO, 1976

1976: J. New York. Entomol. Soc.84:140 - 141; Loc. Typ.: Colonie, Albany County N.Y., Coll.: New York State Museum (new synonym).

Material examined: Holotype and 1 paratype (NYSTM), 1 paratype (USDA), Colonie, Albany County, New York, 10.4.1973, leg. M. D. DELFINADO.

The female designated as "holotype" was mounted together with a paratype female on the same slide. The advanced dessication of the mounting solution precluded microscopic examination of the animals. Both specimens were remounted on individual slides. Their examination showed that in the original description, setae d were incorrectly described and illustrated as being considerably longer than setae f (DELFINADO et al. p.140: " ...d longest of dorsal setae...") while in fact both setae on the NYSTM reference slides are the same length. The USDA paratpye could not corroborate this as both setae d were missing on it. Setae ps2 are considerably shorter on all the specimens than as given in the original description and do not reach half the length of ps1. Morphological comparison of the type material of *Imparipes humilis* with *Imparipes dispar* showed that there are no differences in the characteristics of the two taxa. As there is thus no basis for a species differentiation between *humilis* and *dispar*, *Imparipes humilis* DELFINADO et al., 1976 is established as a junior synonym of *Imparipes dispar* RACK, 1964.

Imparipes (Sporichneuthes) intermedius PAOLI, 1911

1911, *Imparipes* (*Imparipes*) *hystricinus intermedius* PAOLI: 259, Fig. 55, 56, 59; RACK 1964: 189, Fig. 4c.

1980, *Imparipes* (*Imparipes*) *intermedius* PAOLI: MAHUNKA (revision), 388, (Lectotype: Florence, Slide number 128/11, Coll. BERL.).

Material examined: 1 female, Elba, samples-No. EL2-5 (see list of localities); further specimens with a total of 5 females from the Coll. BERL., Florence.

Characteristics	***I. dispar***	***I. intermedius***
average (x) of wastpl : wGn	1 : 0.62	1 : 0.74
length su	does not reach ap2	does not reach ap2
ap5	median incomplete	median incomplete
distance 1a - 1a : 1a - 1b	1a - 1a > 1a - 1b	1a - 1a > 1a - 1b
claw TiTa (I)	present	present
sol TiTa (I)	ω 2 = ω 1= ϕ 2 < ϕ 1	ω 2 < ω 1 > ϕ 2 < ϕ 1
dTi (IV)	blunt	blunt
dF : v'Ti (IV) (length)	dF > v'Ti	dF < v'Ti
lTr : lTa (x)	1 : 0.68	1 : 0.7
lTr : lPrTa (x)	1 : 0.79	1 : 0.62

Tab. 2: Morphological characteristics of species belonging to new Subgenus *Sporichneuthes* compared.

I. kaszabi	*I. aricus*	*I. schusteri* **nov.spec.**
1 : 0.69	1 : 0.64	1 : 0.66
does not reach ap2	does not reach ap2	very long extends beyond ap2
complete or median incomplete	median incomplete	strongly reduced
1a - 1a > 1a - 1b	1a - 1a > 1a - 1b	1a - 1a < 1a - 1b
absent	present	present
ω 2 < ω 1 > ϕ 2 < ϕ 1	ω 2 < ω 1 >ϕ 2 < ϕ 1	ω 2 < ω 1 > ϕ 2 = ϕ 1
pointed	pointed	blunt
dF < v'Ti	dF > v'Ti	dF > v'Ti
1 : 0.61	1 : 0.72	1 : 0.7
1 : 0.66	1 : 0.82	1 : 0.82

Continuation of Tab. 2

According to the list of CASTAGNOLI & PEGAZZANO (1985), the COLLECTIO BERLESE includes 2 slides with label numbers 128/11 and two slides with numbers 128/12 and 128/26, respectively. Both slides numbered 128/11 contain one generally intact mite each. On one of the slides numbered 128/11 and labeled "*Imparipes hystricinus* var. *intermedius* PAOLI Firenze, terriccio di castagno", the mite is lying on its side and so cannot be examined readily. The second slide numbered 128/11 and labeled "*Imparipes intermedius* Firenze terriccio di castagno" was designated by MAHUNKA (1980) as lectotype. During work for this publication in Florence in 1997, this slide was found as labeled but it was n o t designated as "lectotype". The specimen is basically in a good position for examination but some of the ventral setae are severely displaced and overlie each other. The incomplete illustration published by MAHUNKA in 1980 (p. 389, Fig. 27) of the ventral side, which is based on this slide, would suggest, if one were unfamiliar with the actual slide, that setae 2a and 2b and one each of setae 3b and 4c were missing. These setae are in fact all present on the slide but owing to the unfavorable position mentioned above, they can only be partially shown in a drawing. Slide 128/12 labeled "*Imparipes hystricinus* var. *intermedius* PAOLI Firenze terriccio di castagno" contains an intact specimen whose gnathosoma setae su are readily visible. Slide 128/26 labeled "*Imparipes intermedius* Firenze terriccio di castagno" is not mentioned by MAHUNKA (1980) and probably was not examined by him. It contains a generally intact specimen in a good position for examination with the ventral setae well oriented for examination. The illustration of the ventral side presented here (Fig. 5) is based on this specimen.

Further data on taxonomically relevant feature of *I. intermedius*:

Length of dorsalsetae variable: d > f > h1 or d ≅ f > h1 or d < f > h1; e ≅ h2 or e < h2; ap5 medially incomplete; le present, as in *dispar* reduced between the insertions of 1a, distance 1a - 1a > 1a - 1b; setae 4a only slightly before 4b (Fig. 5, 12b); ps2 present, do not reach half the length of ps1, ps2 not shown in PAOLI's original description. In RACK's Fig. 4c (1964, p. 189), ps2 setae are also not shown, following the description by PAOLI; MAHUNKA (1980, Fig. 27) shows the setae ps2. Gnathosoma and pharyngeal pump see Fig. 11c; wastpl wGn = 1 0.71 - 0.77, x = 0.74 (n = 2); when the gnathosoma is folded back the setae su do not reach ap2. Leg I with claw, length of solTiTa (I): ω2 < ω1 > φ2 < φ1, ω2 and φ2 minute, φ1 thinly stemmed, distally thickened, pointed, ω1 distally pointed. Leg IV (Fig. 6a): Relation lTr lTa = 1 0.67 - 0.72, x = 0.7 (n = 2); relation lTa : lPrTa (without empodium) = 1 : 0.61 (= specimen from Elba), 1 : 0.62 (= slide Coll. BERL.No.128/26), 1 : 0.63 (= lectotype); PrTa with tiny claws that are almost completely reduced on some specimens, empodium elongated, with a piston-like widening in the middle;

setae dF < v'Ti, dTi thin out distally, but are blunt at the ends, tc' very fine toward the end, length pv" variable, u' inserts just next to pv', u' is the shortest tarsal seta; solTi dorsal from v'Ti and minute.

Differentiation from other species of the subgenus (see Table 2):

Imparipes intermedius is habitually close to *I. dispar* but differs from it in the following characteristics: Gnathosoma generally wider, different length ratios of solTiTa (I), dF < v'Ti (IV), distance between setae 4a - 4b distinctly shorter, average length of the pretarsus IV distinctly shorter; *intermedius* differs from *I. kaszabi* in different structure of 1e, different position of 4a - 4b, presence of a claw on TiTa and in the blunt end of seta dTi (IV); *intermedius* differs from *I. aricus* in its generally wider gnathosoma, different structure of 1e, different position of 4a and 4b, in dF > v'Ti, and in a generally distinctly shorter pretarsus IV; *intermedius* differs from *I. schusteri* nov. spec. through relatively longer dorsal setae, a wider gnathosoma, considerably shorter setae su, more comple ap5, greater distance from 1a - 1a in comparison to 1a - 1b, different position of 4a and 4b, different length ratio for solTiTa (IV), in dF < v'Ti (IV), and in a generally shorter pretarsus IV.

The distally widened empodium found in *intermedius* was not included in the comparison of characteristics. This is because the small numbers of individuals examined so far does not allow for intraspecific variability of this feature. *Imparipes aricus* suggests the variability of the form of the empodium.

Imparipes (*Sporichneuthes*) *kaszabi* MAHUNKA, 1967

Material examined: Holotype (Mongolia, T-575p-67(i), No.431, Cojbalsan aimak, 17.8.1965, leg. KASZAB); Paratypes from 2 (!) different sites (Mongolia, locality like the holotype, further Mongolia, T-576p-67(i), No. 454, Chentej aimak, 20.8.1965, leg. KASZAB), as well as other reference material labeled "Mongolia, No.792, South Gobi aimak, 12.6.1967, leg. KASZAB" as well as "Dariganga Ulan-Bator-tol DK-re, 18.8.1972" (see MAHUNKA 1973).

Additional information on taxonomically relevant characteristics of *I. kaszabi*:

Setae d < f > h1; le present, continues mediad from the insertion of 1a, interrupted before the spout (Fig. 12b); distance 1a - 1a > 1a - 1b; ap4 short, ap5 complete or medially incomplete (Fig. 7a); setae 4a only slightly before 4b, positions relatively variable (Fig. 13c); for gnathosoma and pharyngeal pump see Fig. 11d; relation wastpl : wGn = 1 : 0.61 - 0.75, x = 0.69 (n = 10), s = 5.27; when the gnathosoma is folded back the setae su do not reach ap2.

Setal formula leg I: Tr 1, Fe 3, Ge 4, TiTa 16 (4sol), TiTa (I) without claw (Fig. 7b), length solTiTa (I): ω2 < ω1 > φ2 < φ1, ω2 and φ2 tiny, φ1 thin stemmed, pointed, ω1 with distal point (Fig. 7b); leg IV (Fig. 6b); relation lTr : lTa = 1 : 0.6 - 0.64 (holotype 0.61), x = 1 : 0.61 (n = 5), s = 2.19, relation lTa lPrTa (without empodium) = 1 0.61 1 0.7 (holotype 0.62), x = 1 0.66 (n = 5), s = 3.27; pretarsus with slender, elongated empodium, claws reduced; setae dF < v'Ti, tarsus with 5 setae, u' short and thin, tc' much thicker than dTi, dTi and tc' end in a fine filament (this is drawn too short in the original description), solTi dorsal from v'Ti.

Differentiation from the other species of the subgenus (see Table 2)

Imparipes kaszabi can be differentiated from all the other species of the subgenus due to the exclusive feature of a clawless TiTa (I). In some specimens of *kaszabi* ap5 is completely formed and this is a feature that could not be found in other species of the genus. *Imparipes kaszabi* differs from *I. dispar* further through differing structure of 1e, different position of 4a - 4b, different length relation of solTiTa (I), through pointed seta dTi (IV), through dF < v'Ti (IV) as well as through a distinctly shorter pretarsus IV. *I. kaszabi* differs from *I. intermedius* through different structure of 1e and further through the pointed seta dTi (IV); the position of 4a - 4b sometimes agrees with *intermedius* and both species show the feature dF < v'Ti (IV) that is rare in this genus, further there is the relatively short pretarsus IV; distinctions to *I. aricus* are the different structure of 1e, the position of 4a - 4b, dF < v'Ti and on the average a distinctly shorter pretarsus IV; *Imparipes kaszabi* and *I. schusteri* nov. spec. share an identical structure of 1e; *I. kaszabi* differs from *I. schusteri* nov. spec., besides in the absence of a claw on TiTa (I), in eight characteristics: More complete ap5, setae su much shorter, greater distance from 1a - 1a in comparison to 1a - 1b, the position of 4a and 4b, a different length relationship of solTiTa (I), dTi (IV) is pointed, dF < v'Ti, and a pretarsus that on the average is much shorter.

Imparipes (Sporichneuthes) aricus MAHUNKA, 1971

Material examined: 11 females, including 6 paratypes, 3 reference slides from locus typicus (As-144, No.292, Jabalpur, 1.4.1967, leg.Topal.) and 2 females from Jagdelpur/India, see list of localities.

Additional information on taxonomically relevant characteristics of *I. aricus*:

Dorsal setae vary considerably in length: d > f > h1 or d ≅ f > h1 or d > f < h1 or d ≅ f ≅ h1; 1e present, continues mediad from the insertion of 1a parallel to the posterior edge of ap1, interrupted before the spout (Fig. 12c); ap5 me-

dian incomplete (Fig. 7c), for gnathosoma and pharyngeal pump see Fig. 11e; relation wastpl : wGn = 1 : 0.62 - 0.68, x = 0.64 (n = 9), s = 2.12; with folded gnathosoma the setae su do not reach ap2; trichobothrium (Fig. 7d) club-shaped, thinly stemmed with fine distal scales, v2 present (giving as missing in the original description), v1 > v2; distance 1a - 1a > 1a - 1b; setae 4a are before 4b (Fig. 13d), ps2 shorter or longer than half the length of ps1; length sol TiTa (I): ω2 < ω1 > φ2 < φ1, ω2 and φ2 slender, φ1 with thin stem, pointed, ω1 with distal point (Fig. 7e); leg IV: Relation lTr : lTa = 1 : 0.63 - 0.81, x = 0.72 (n = 11), relation lTa lPrTa (without empodium) = 1 : 0.61 - 0.93, x = 0.82 (n = 11), pretarsus with slender, elongated empodium and two long, fine claws or pretarsus with short, somewhat wider empodium and the claws then reduced, setae dF > v'Ti, tarsus with 5 setae, dTi and tc' end in a fine filament ("pointed"), pl" recognizable as a minute thorn, solTi dorsal from v'Ti, thin stemmed (Fig. 7f).

Differentiation from the other species of the subgenus (see Table 2): *Imparipes aricus* differs from *I. dispar* in the following characteristics: Different structure of 1e, length relation of solTiTa (I), other position of 4a - 4b and dTi (IV). Differences to *I. intermedius* are found in the generally more slender gnathosoma, other structure of 1e, other position of 4a - 4b, the pointed dTi (IV) and in the generally longer pretarsus IV. *Imparipes aricus* differs from *I. kaszabi* in the following characteristics: Differing structure of 1e, different position of 4a - 4b, presence of a claw on TiTa (I), dF > v'Ti (IV), as well as in a generally longer pretarsus. *Aricus* differs from *I. schusteri* nov. spec. in its differing structure of 1e, more complete ap5, much shorter setae su, greater distance 1a - 1a as compared to 1a - 1b, different length ratio of solTiTa (I) and dTi (IV) pointed; position of 4a - 4b agrees with *I. schusteri* nov. spec. in some cases.

Imparipes (Sporichneuthes) schusteri nov. spec.

DESCRIPTION (female)

Body dimensions (values for individual sites)

wastpl: Galapagos Archipelago: 38 - 53, x = 46 (n = 17), s = 4.19 (Holotype 53); Mexico (MEX-1): 49 (n = 2); Mexico (MEX-2): 46 - 48, x = 47 (n = 9), s = 0.64; El Salvador: 46 - 48 (n = 2); Brazil: 46 - 49 (n = 2).

wpstpl: Galapagos Archipelago: 64 - 84, x = 76 (n = 17), s = 6.74 (holotype 84); Mexico (MEX-1): 82 (n = 2); Mexico (MEX-2): 73 - 80, x = 76 (n = 9), s = 2.44; El Salvador: 77 - 79 (n = 2); Brazil: 73 - 83 (n = 2).

wGn: Galapagos Archipelago: 28 - 31, x = 30 (n = 17), s = 1,16 (holotype 31); Mexico (MEX-1): 36 - 40 (n = 2); Mexico (MEX-2): 30 - 34, x = 31 (n = 9), s = 1.48; El Salvador: 31 - 32 (n = 2); Brazil: 31 - 36 (n = 2).

Fine pores over the entire surface of the body creates a stippled appearance. Tergit C large, covers more than half of the dorsal side, its free margin with fine radial stripes (not shown in Fig. 8), cupulae ia and ih rounded.

Dorsum (Fig. 8): Setae vary considerably in length, as seen in animals from all the sites: c1 ≅ c2 (most commonly) or c1 > c2 or c1 < c2; d < f (most commonly) or d ≅ f or d > f (rarely); f ≅ h1 (most commonly) or f < h1 or f > h1; e ≅ h2 or e < h2 or e > h2.

Venter (Fig. 9): ap1 and ap2 well developed, ap3 absent, ap4 does not reach half the width of the posterior sternal plate, ap5 reduced except for a slight lateral remnant. 1a inserts on 1e, 1e reduced in the area of the insertions of 1a, width of 1e and length vary mediad (Fig. 12d): 1e mediad lengthened and widened or 1e over 1a mediad lengthened but with constant width or 1e ends with 1a. Distance 1a - 1a < 1a - 1b; length of the ventral setae may vary, i. e. identical setae on the left and right sides of the body may differ considerably in length: 1a, 1 b and 2a about the same length, densely barbed, 2b dagger-shaped, smooth; length 3a ≅ 3b < 3c, all barbed, 4a before 4b, 4a < 4b > 4c, all barbed, ps1 > ps2 < ps3, ps2 smooth, shorter or longer than half the length of ps1.

Gnathosoma (Fig. 9, 11f): Relation of wastpl wGn = 1 0.59 - 0.76, holotype 1 : 0.6; x = 1 : 0.66 (n = 30, includes animals from all localities), s = 4.3; setae su reach far beyond ap2 when the gnathosoma is folded back; pharyngeal pump see Fig. 11f .

Trichobothrium sc1 (Fig. 10a): Club-shaped, thin stemmed, with fine scales distally, v1 > v2.

Extremities: Leg I (Fig. 10b): Setal formula: Tr 1, Fe 3, Ge 4, TiTa 16 (4sol); TiTa slender, powerful claw with sharp tip; length of ω2 < ω1 > ϕ2 = ϕ1, ω1 finger-shaped, pointed distally, ϕ1 thin stemmed, club-shaped, pointed distally.

Leg II (Fig. 10c): Setal formula: Tr 1, Fe 3, Ge 3, Ti 4 (1sol), Ta 6 (1sol), solTi small, solTa almost twice as long, pointed distally, Ta with two claws and empodium.

Leg III (Fig. 10d): Setal formula: Tr 1, Fe 2, Ge 2, Ti 4 (1 sol), Ta 6; solTi very small, Ta 2, with claws and empodium.

Leg IV (Fig. 10e): Setal formula: Tr 1, Fe 2, Ge 1, Ti 3 (1 sol), Ta 5 - 6.

Relation lTr : lTa = 1 : 0.61- 0.8 (holotype 0.68), x = 1 : 0.7 (n = 25, includes animals from all localities), s = 4.24; values for the individual localities: Galapagos Islands = 1 : 0.61 - 0.8, x = 0.69 (n = 10), s = 5.47; Mexico (MEX-1) = 1 : 0.66 - 0.7 (n = 2); Mexico (MEX-2) = 1 : 0.64 - 0.75 (n = 8); El Salvador = 1 : 0.7 - 0.71 (n = 2); Brazil = 1 : 0.73 - 0.76 (n = 3).

Relation lTa : lPrTa (without empodium) = 1 : 0.63- 0.96 (holotype 0.87), x = 0.82 (n = 25, includes animals from all localities), s = 8.24; values for individual sites: Galapagos Archipelago = 1 : 0.63 - 0.87, x = 0.78 (n = 10), s = 8.9; Mexico (MEX-1) = 1 : 0.92 - 0.96 (n = 2); Mexico (MEX-2) = 1 : 0.81 - 0.95 (n = 8); El Salvador = 1 : 0.75 - 0.81 (n = 2); Brazil = 1 : 0.79 - 0.84 (n = 3).

PrTa with fine claws, empodium elongated, narrow. Setae dF > v'Ti, length dTi ≅ tc', dTi very thin distally but with a blunt end, tc' thins out with a fine pointed tip, pv" extends clearly beyond the empodium; u' inserts just beside pv'; seta pl" may occur as 6th tarsal seta, very thin and fine when present, solTi dorsal from v'Ti, thin stemmed.

Male and larva: Unknown.

Material examined: 34 females.

Locus typicus (see list of localities): GAL-87-499, holotype, 7 paratypes; further localities are GAL-87-496 (1 female), GAL-87-500 (1 female), GAL-87-533 (1 female), GAL-87-675 (1 female), GAL-87-707 (2 females), GAL-87-779 (1 female), GAL-91-S12 (1 female), GAL-91-S25 (1 female), MEX-1 (2 females), MEX-2 (10 females), Salvador 68 Mi II (2 females), BR-214 (3 females).

Deposition of types and reference slides

Holotype, 3 paratypes and reference slides from Mexico, El Salvador and Brazil at the ZMH, 3 paratypes at the HNHM, 1 paratype and further reference material in the author's collection.

Etymology: The name "*schusteri*" is dedicated to my academic teacher Prof. Dr. R. SCHUSTER with gratitude for his support nearly 30 years.

Differentiation from other species in the subgenus (see Table 2)

The new species has 4 exclusive characteristics: These are very long setae su that extend beyond ap2, very reduced ap5, distance from 1a - 1a in comparison to 1a - 1b is smaller, and there are the relatively short dorsal setae. These characteristics clearly distinguish *I. schusteri* nov. spec. from the other species in the subgenus. In addition, *I. schusteri* nov. spec. differs from *I. dis-*

par in its different structure of 1e, different position of 4a - 4b and a different ratio of solTiTa (I). Characteristics that differ from *I. intermedius* are the different structure of 1e, different position of 4a - 4b, dF > v'Ti (IV) and a pretarsus IV, that on the average is longer. Differences to *I. kaszabi* are the differing position of 4a - 4b, the presence of a claw on TiTa (I), a different length ratio of solTiTa (I), a blunt seta dTi (IV), dF > v'Ti (IV) and a generally considerably longer pretarsus IV. Distinctions to *I. aricus* are the different form of 1e, the differing length ratio of solTiTa (I) and the blunt seta dTi (IV); the position of 4a - 4b may in some cases agree with *aricus*.

Distribution of the subgenus Sporichneuthes

a) List of new records:

EUROPE

Imparipes (S.) dispar

Austria: Dobl SW of Graz, manure in an outdoor compost heap, generally composted, 10.11. 1987, leg. E. EBERMANN.

Haselsdorf, SW of Graz, in an outdoor compost heap for kitchen and garden waste, carpet of *Aspergillus ustus* fungus on coffee dregs, samples taken from September 1992 onward, leg. E. EBERMANN.

Imparipes (S.) intermedius

Italy: Sample No. EL 2-5: Island of Elba, Madonna delle grazie, a layer of pine needles up to 10 cm thick, heavily infiltrated with fungus in places, upon sandy underground; 23.9.1985, leg. E. EBERMANN.

ASIA

Imparipes (S.) aricus

India: Jagdelpur, Madhya Pradesh, "litter of moist decid. Forest", 12.3.1987, leg. A. SKALSKI, (Collection W. MAGOWSKI).

SOUTH-AND CENTRAL-AMERICA

***Imparipes (S.) schusteri* nov. spec.**

Mexico: MEX-1: Veracruz, Guiérrez Zamora, Barriles. Orange fields, ex litter, 18.9.1977, leg. J. G. PALACIOS-VARGAS.

MEX-2: Otongo, State of Hidalgo, Prov. Molango, litter and soil, in forest, 4.10.1980, leg. K. LUNA.

EL Salvador: Salvador 68 Mi II : San Marcos Lempa, east bank of the Rio Lempa, south of Puento d'oro, 13°25'N, 88°40'W, moist lowland forest, sample: Well developed straw layer over humid mixed soil up to 60 cm deep, samples taken from straw and rotten wood; 27.4.1956, leg. K.-H. SCHÖMANN.

Galapagos Archipelago (samples taken, when not otherwise specified, by H. SCHATZ and I. SCHATZ):

GAL-87-496: Santa Cruz Island, northern part, west of Canal de Itabaca, littoral zone, 5m, moist, partially decayed mangrove leaf litter and sand under *Avicennia germinans*; 13.1.1987.

GAL-87-499: Santa Cruz Island, northern part, arid zone, 250 m, dry to moist leaf litter and humus between rocks under *Pisonia floribunda* and *Acacia*; 13.1.1987.

GAL-87-500: ibid., dry to moist deeper litter layers and humus under rocks; 13.1.1987.

GAL-87-533: Floreana Island, highland north of Cerro Pajas, near trail to Finca, cultivated area, 340 m, moist, decayed leaf litter with pieces of wood, roots and humus under *Kalanchoe pinnata*, *Lantana camara* (introduced) and *Croton scouleri var. brevifolius*; 18.1.1987.

GAL-87-675: South Plaza Island, northern part of the island, Arid zone, 10 m, moist litter and humus under *Castela galapageia*; 20.2.1987.

GAL-87-707: Santiago Island, at spring below Pan de Azucar, Arid zone, 40 m, moist to wet, decayed leaf litter with pieces of wood and humus under *Clerodendrum molle var. molle* and *Heliotropium angiospermium*; 21.2.1987.

GAL-87-779: Gardner Island near Española, arid zone, 40 m, dry to moist cactus litter under *Opuntia megasperma var. orientalis*; 14.3.1987.

GAL-91-S12: Isabela Island, Alcedo volcano, 850 m, moist highland, leaf litter and humus in open forest of *Burseria graveolens*; 25.6.1991, leg. S. ABEDRABBO.

GAL-91-S25: Fernandina Island, moist zone on the western part of the island, 400 m, decayed leaf litter in forest; leg. S. ABEDRABBO.

Brazil: BR-214: Southern Recife (Pernambuco), Barra das Jangadas (Rio Jaboatão), well decayed leaf litter with humus, under trees, sandy underground near the edge of a mangrove but purely terrestrial, about 4 m asl, October 1960, leg. R. SCHUSTER.

b) Distribution of the species

Currently known localities for the subgenus *Sporichneuthes* see Fig. 14.

Imparipes dispar: The first record by RACK (1964) from Hamburg and further records by DELFINADO et al (1976, *I. "humilis"*) from New York and EBERMANN (first Austrian record, this paper) are the only indications of a holarctic distribution. The distinctly phoretic behaviour of *I. dispar* observed by EBERMANN (paper in prep.) is important for the interpretation of the currently known distribution pattern

All the other records of *I. dispar* published since 1964 were studied on the basis of reference slides: ATHIAS 1973 (Côte d'Ivoire): 129-130; NIEDBAŁA et al. 1981 (Poland): 120; NIEDBAŁA et al. 1982: 284 (Poland); FAIN et al. 1992: 336 (Belgium); BŁOSZYK et al. 1994 (Poland). These were all misidentifications.

Imparipes intermedius: This species was described by PAOLI (1911) in the vicinity of Florence. The only other record to date is EBERMANN's (this paper) from the Island of Elba.

Imparipes kaszabi: The first record (1967) and all later records published by MAHUNKA (1969a, 1970, 1973) were from different parts of Mongolia. There have been no further records to date.

Imparipes aricus: The only two records (MAHUNKA 1971 and EBERMANN, this paper), both from Madhya Pradesh, India, do not presently permit any conclusions to be drawn on the distribution of this species.

Imparipes schusteri nov. spec.: The records from 7 islands in the Galapagos Archipelago as well as the known neotropic distribution (Mexico, El Salvador, Brazil) indicate phoresy as an important factor in the dispersion of this species. The distance between the localities in Brazil and the Galapagos which are some 6500 km apart is remarkable, though. This geographical situation leaves open the question as to whether there is actually a continuous east-west distribution in the northern part of South America.

Discussion

All the species of *Sporichneuthes* show agreement, even down to details, in the structure of their gnathosoma. This, together with the spout-like formation on the circumgnathosomal foramen, that is not found in any other genus and the shifted stigmata, serves as a highly specific combination of characteristics. Furthermore the specialized feeding mode demonstrated for *Imparipes dispar* (EBERMANN paper in prep.) and also highly likely for the other *Sporich-*

neuthes species, should be sufficient to establish the species discussed in this paper as a monophyletic group.

The genus *Imparipes* BERLESE, 1903 is represented by three subgenera so far, i.e. *Imparipes* s.str. PAOLI, 1911, the monotypic subgenus *Parimpipes* MAHUNKA, 1975 and *Telodispus* KARAFIAT, 1959. Of these three taxa, only the subgenus *Parimpipes* with the species *Imparipes* (*Parimpipes*) pharyngealis shows characteristics that indicate deviation from the "norm" in the structure of the gnathosoma and pharyngeal pump. The gnathosoma capsule of *I. pharyngealis* is unusually elongated and is, in fact, nearly twice as long as it is wide. The elongated pharyngeal pump has only two parts (in the subgenus *Imparipes* there are three parts) and the anterior section covers the anterior edge of the second section of the pump like a cap.

The genus *Rhynchodispus* described by MAHUNKA (1969b) from Bolivia with two species is, like *I.* (*Parimpipes*), characterised by the notable elongation of the gnathosoma capsule. The most aberrant gnathosoma is found in *Nasutiscutacarus* BEER & CROSS, 1960, described with two phoretic species of Philippine wild bees (*Nomia*). Here, the gnathosoma capsule is extremely elongated and narrows down distally to form a tube. None of the species belonging to *I.* (*Parimpipes*), *Rhynchodispus* and *Nasutiscutacarus* has been studied with respect to feeding behaviour.

Summary

The new subgenus *Imparipes* (*Sporichneuthes*) is distinguished by morphological characteristics found on the outer gnathosoma and adjoining parts. The new subgenus includes five species: *Imparipes dispar* RACK, 1964, *I. intermedius* PAOLI, 1911, *I. kaszabi* MAHUNKA, 1967, *I. aricus* MAHUNKA, 1971 and *I. schusteri* nov. spec. *Imparipes humilis* DELFINADO, BAKER & ABBATIELLO, 1976 is synonymised with *Imparipes dispar* RACK, 1964. A redescription of *Imparipes dispar* and the description of *I. schusteri* nov. spec. are presented. The species characteristics of *I. intermedius*, *I. kaszabi* and *I. aricus* are discussed on the basis of types and other material. Seventeen new localities in Europe, Asia, South- and Central America and the Galapagos Archipelago are listed and a distribution map of the new subgenus *Sporichneuthes* is shown.

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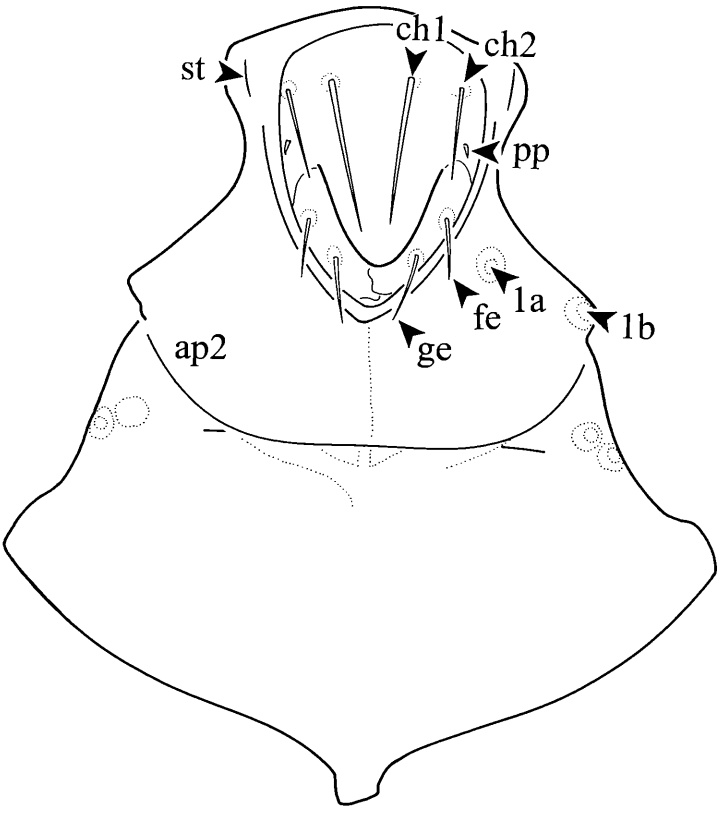
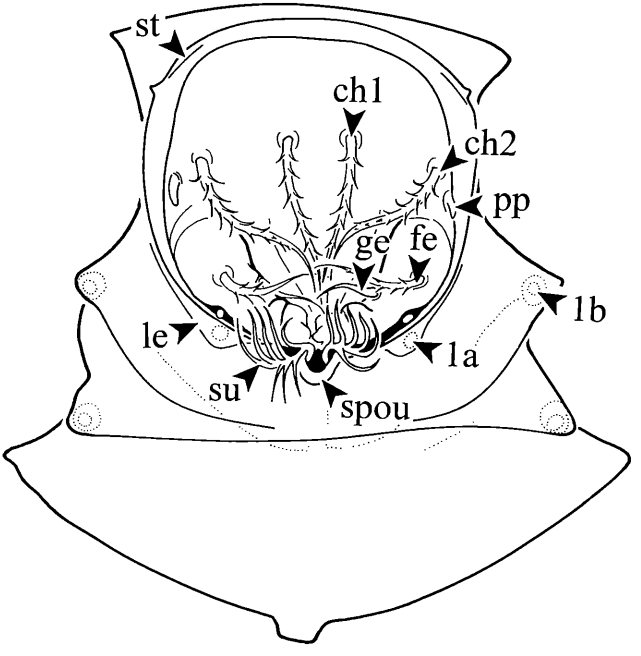
Fig. 1: Ventral propodosoma with gnathosoma: →
a) *Imparipes* (*Imparipes*), b) *Imparipes* (*Sporichneuthes*).



a



b

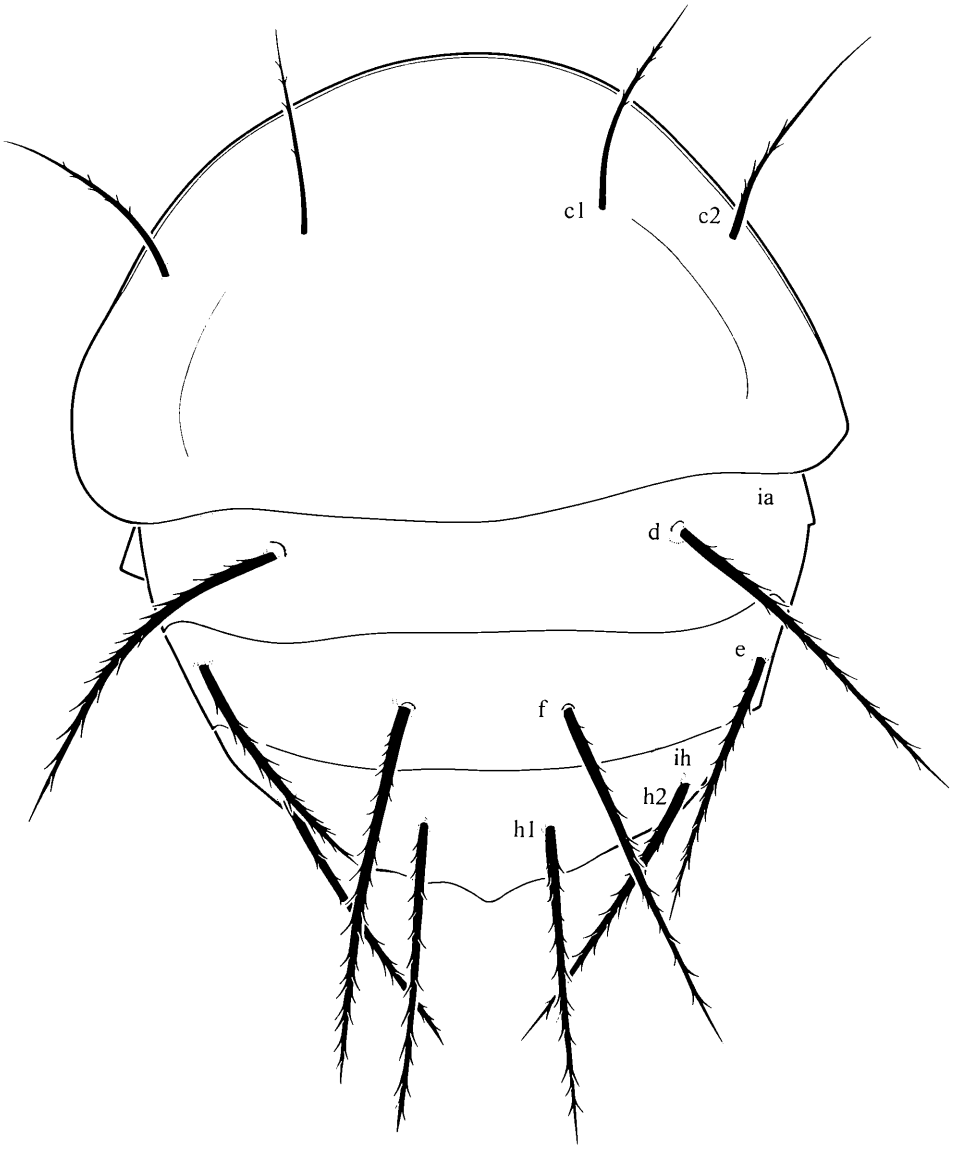


Fig. 2: *Imparipes (S.) dispar* RACK, 1964, female (Holotype): Dorsum, body length 175µm.

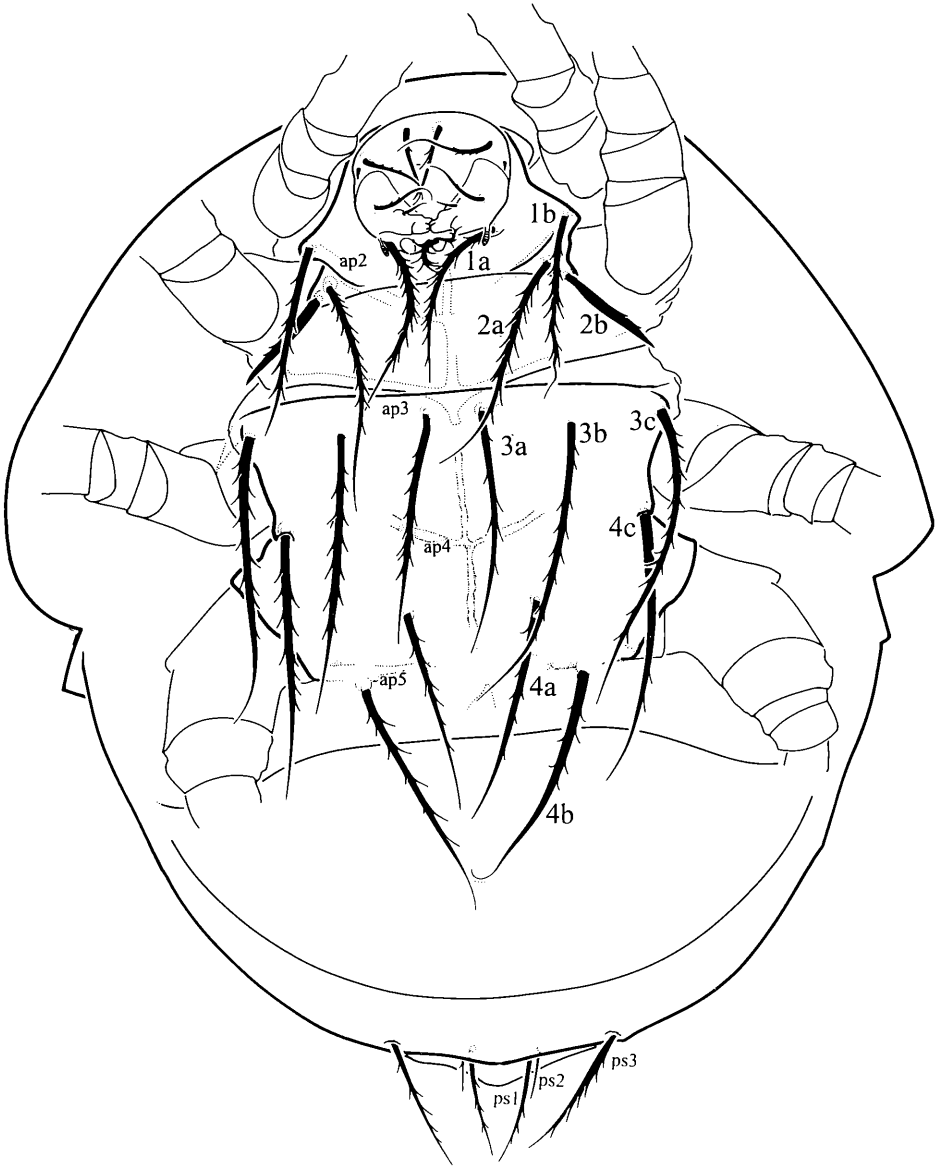


Fig. 3: *Imparipes (S.) dispar* RACK, 1964, female (Holotype): Venter.

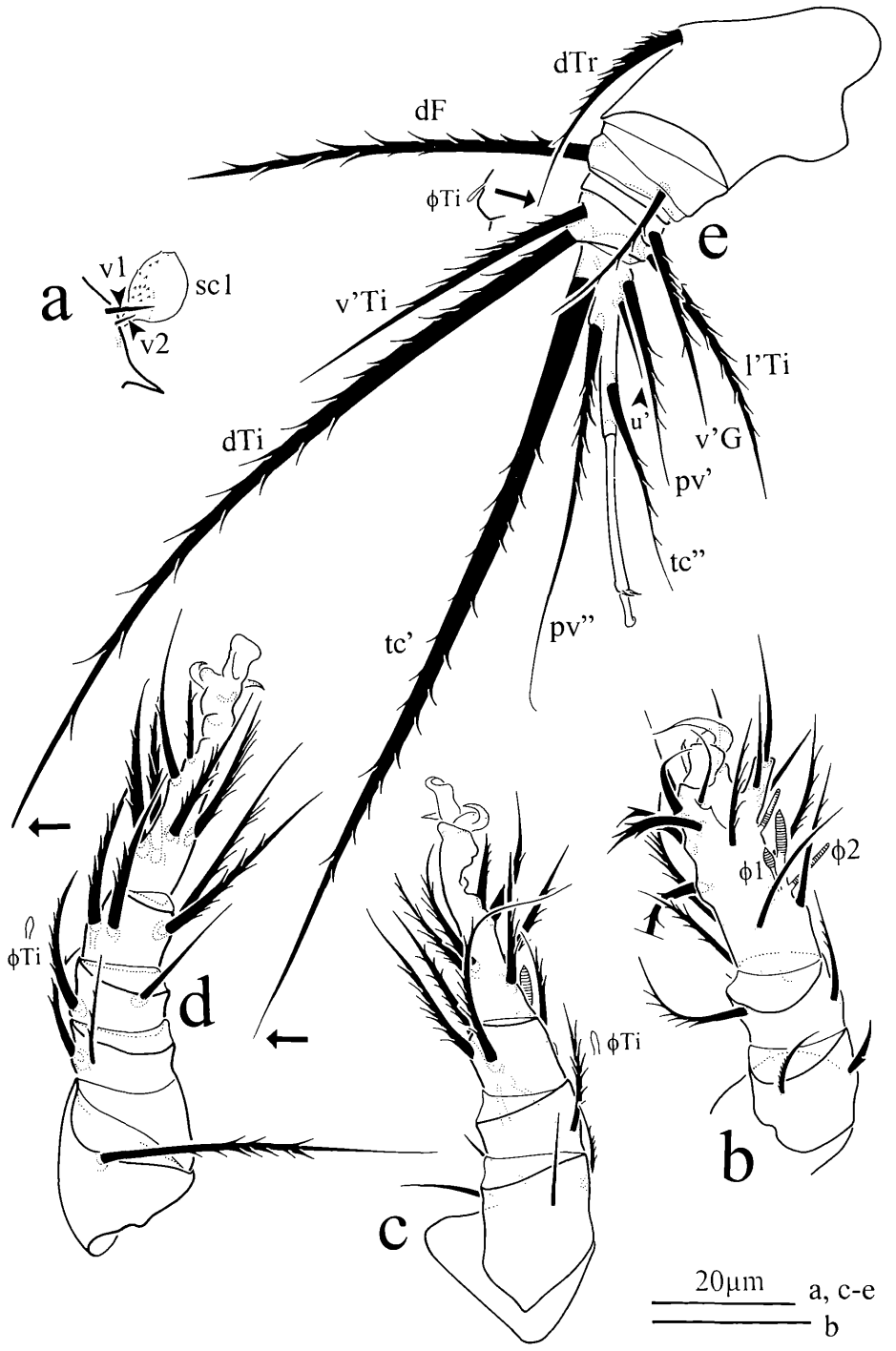


Fig. 4: *Imparipes (S.) dispar* RACK, 1964, female (Holotype): a) Trichobothrium, b) Leg I, c) Leg II, d) Leg III, e) Leg IV.

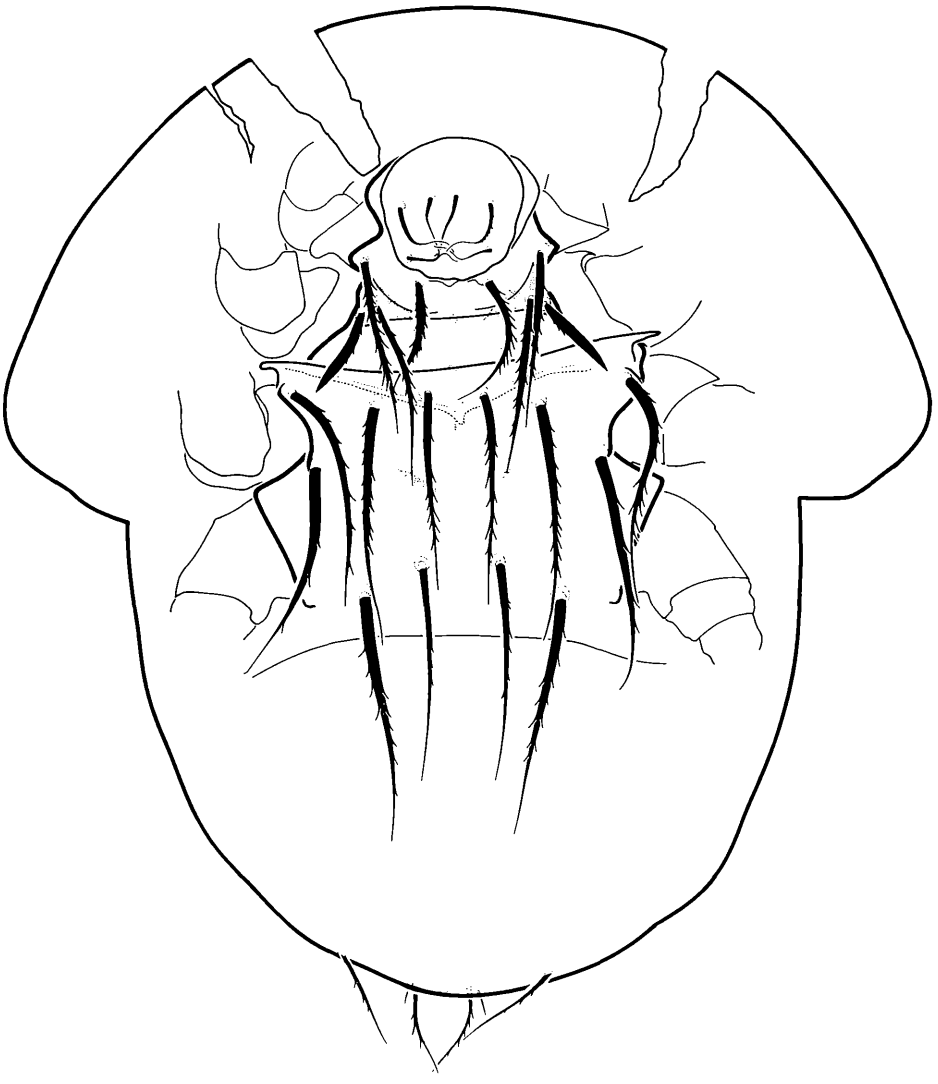


Fig. 5: *Imparipes (S.) intermedius* PAOLI, 1911, female: Ventral view (specimen 128/26, Coll. BERL.).

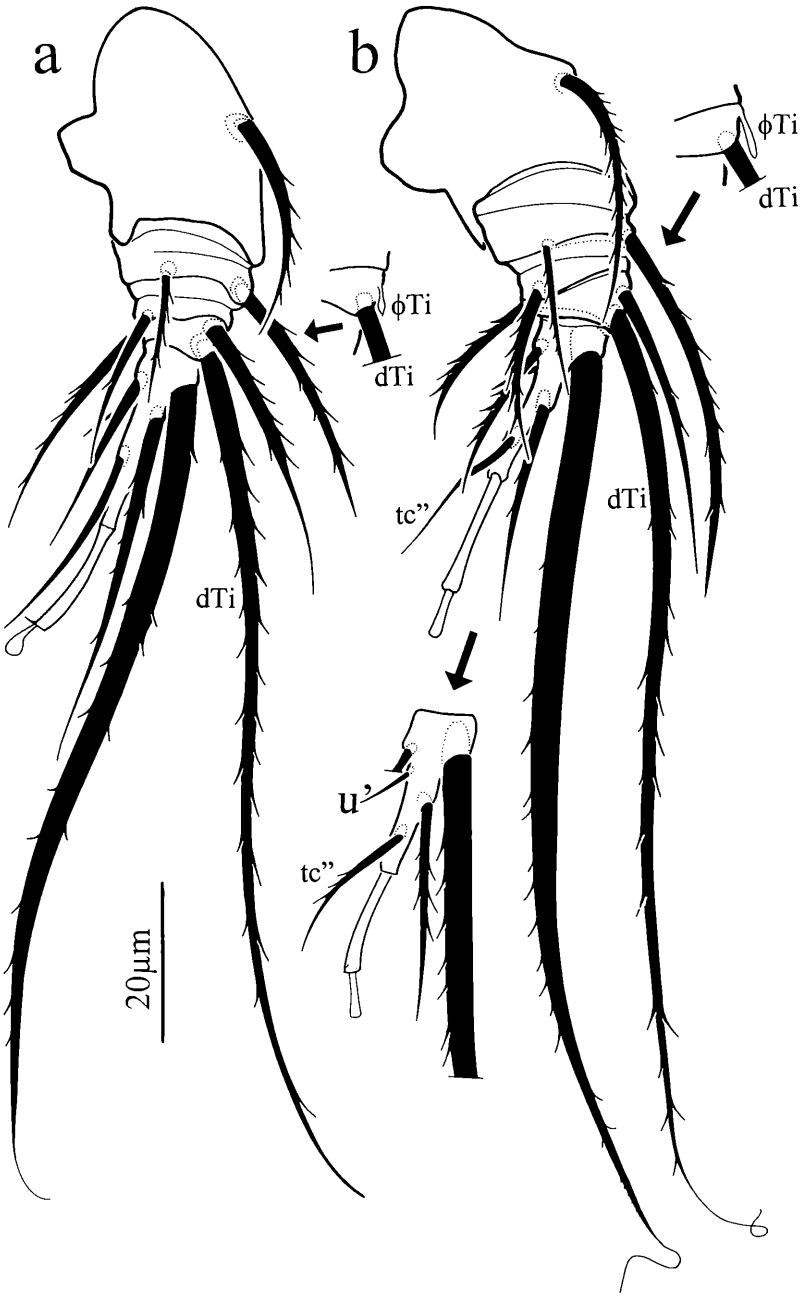


Fig. 6: a) *Imparipes (S.) intermedius* PAOLI, 1911, female: Leg IV, ventral, (specimen 128/26, Coll. BERL.), arrow: tibial solenidion f, dorsal; b) *Imparipes (S.) kaszabi* MAHUNKA, 1967, female (paratypes): Leg IV, ventral, upper arrow tibial solenidion f, dorsal, lower arrow: Tarsus IV of a different specimen, pv' drawn shortened to show u'

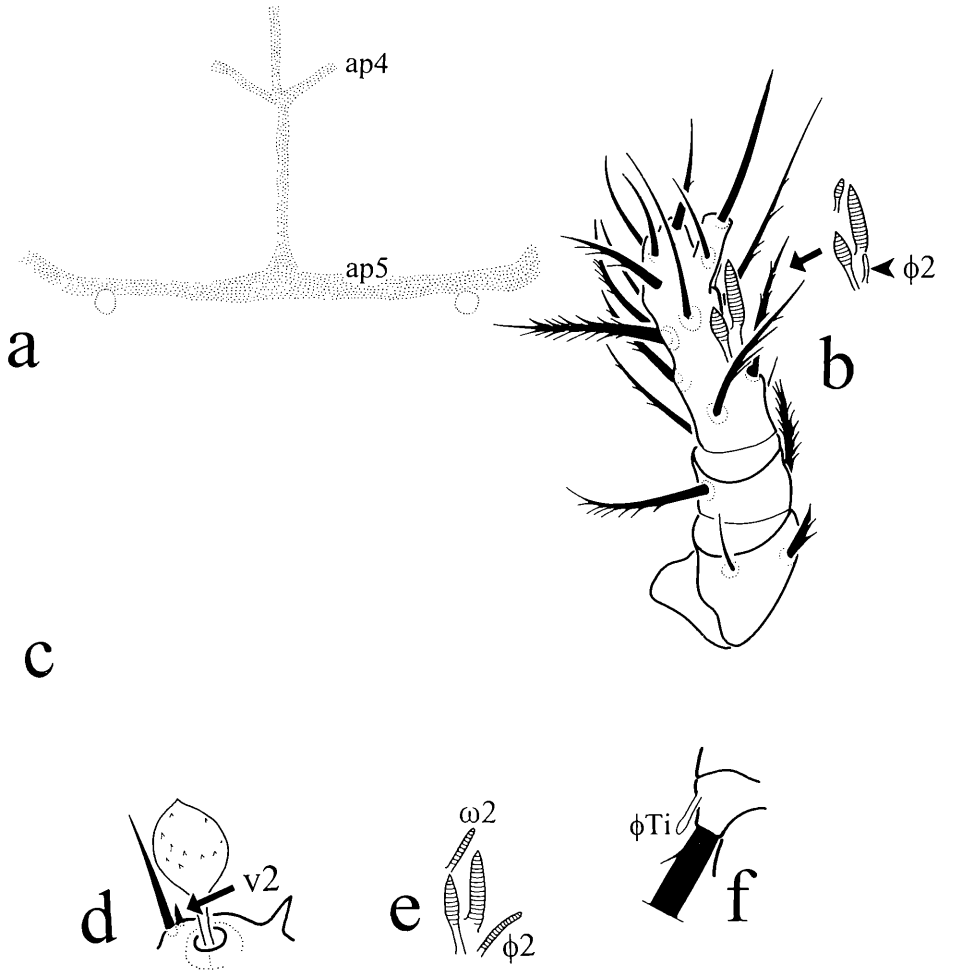


Fig. 7: a + b) *Imparipes (S.) kaszabi* MAHUNKA, 1967, female: a) Examples for the variability of ap5, b) Leg I (holotype); c – f) *Imparipes (S.) aricus* MAHUNKA, 1971, female: c) ap5, d) Trichobothrium, e) Solenidia of leg I, f) Solenidion of leg IV.

Fig. 8: *Imparipes (S.) schusteri* nov. spec., female (holotype): Dorsum, body length 204µm.

Fig. 9: *Imparipes (S.) schusteri* nov. spec., female (holotype): Venter.

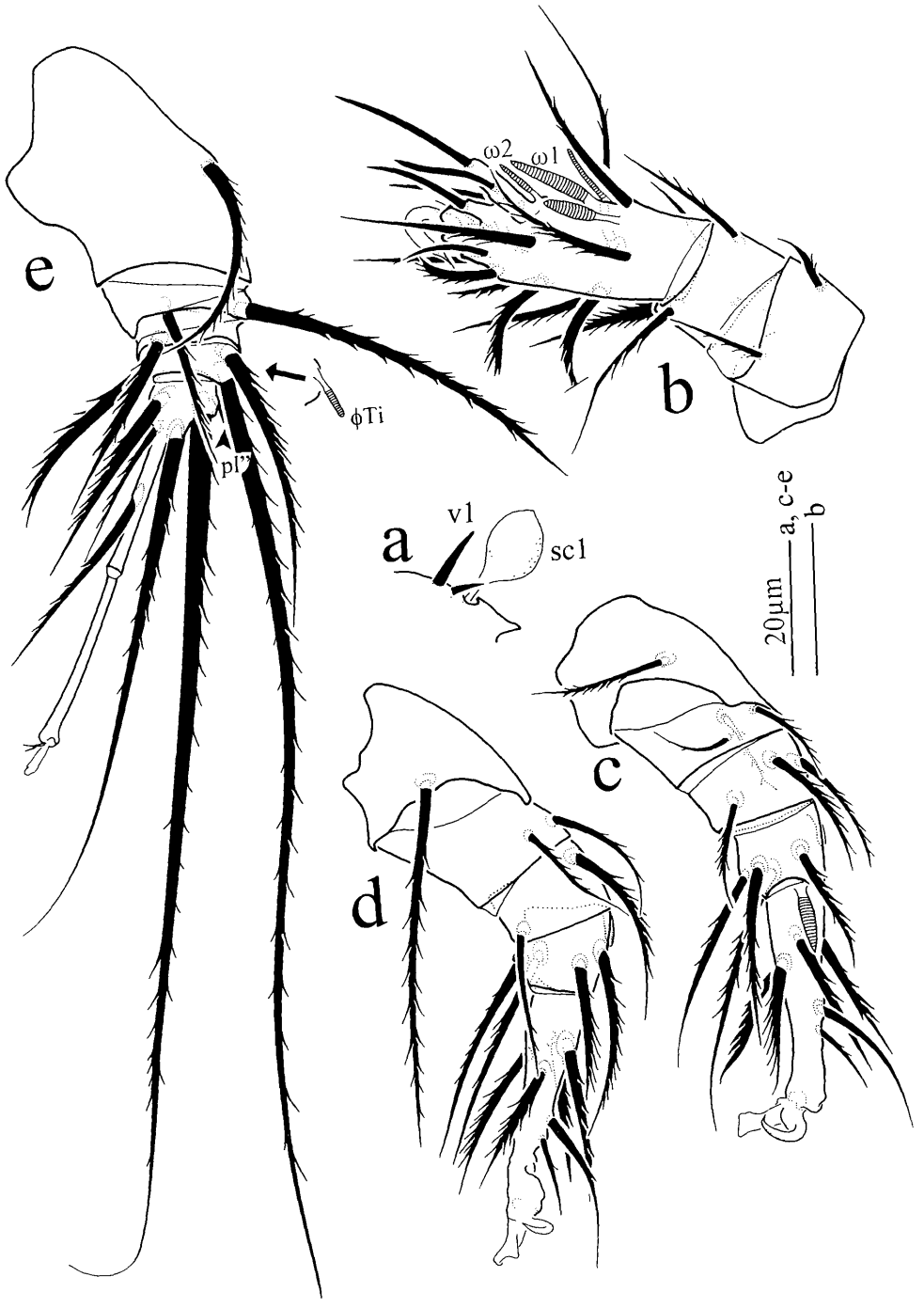


Fig. 10: *Imparipes (S.) schusteri* nov. spec., female (holotype): a) Trichobothrium, b) Leg I, c) Leg II, d) Leg III, e) Leg IV.

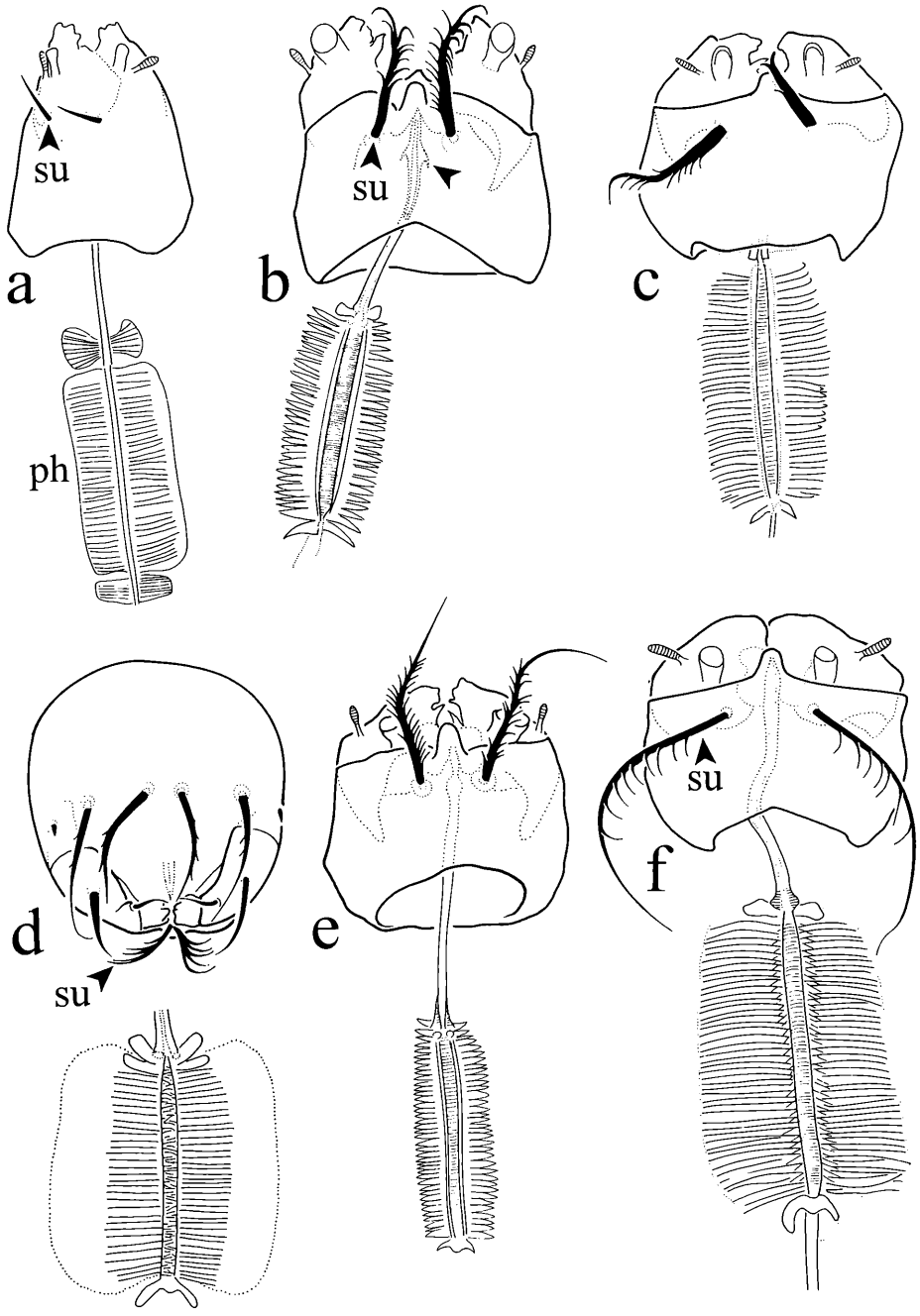


Fig. 11: Gnathosoma (a-c and e-f ventral, d dorsal) and pharyngeal pump: a) *Imparipes* (*Imparipes*) spec., b) *Imparipes (S.) dispar*, c) *Imparipes (S.) intermedius*, d) *Imparipes (S.) kaszabi*, e) *Imparipes (S.) aricus*, f) *Imparipes (S.) schusteri* nov. spec.; ph = pharyngeal pump, su = subcapitular setae.

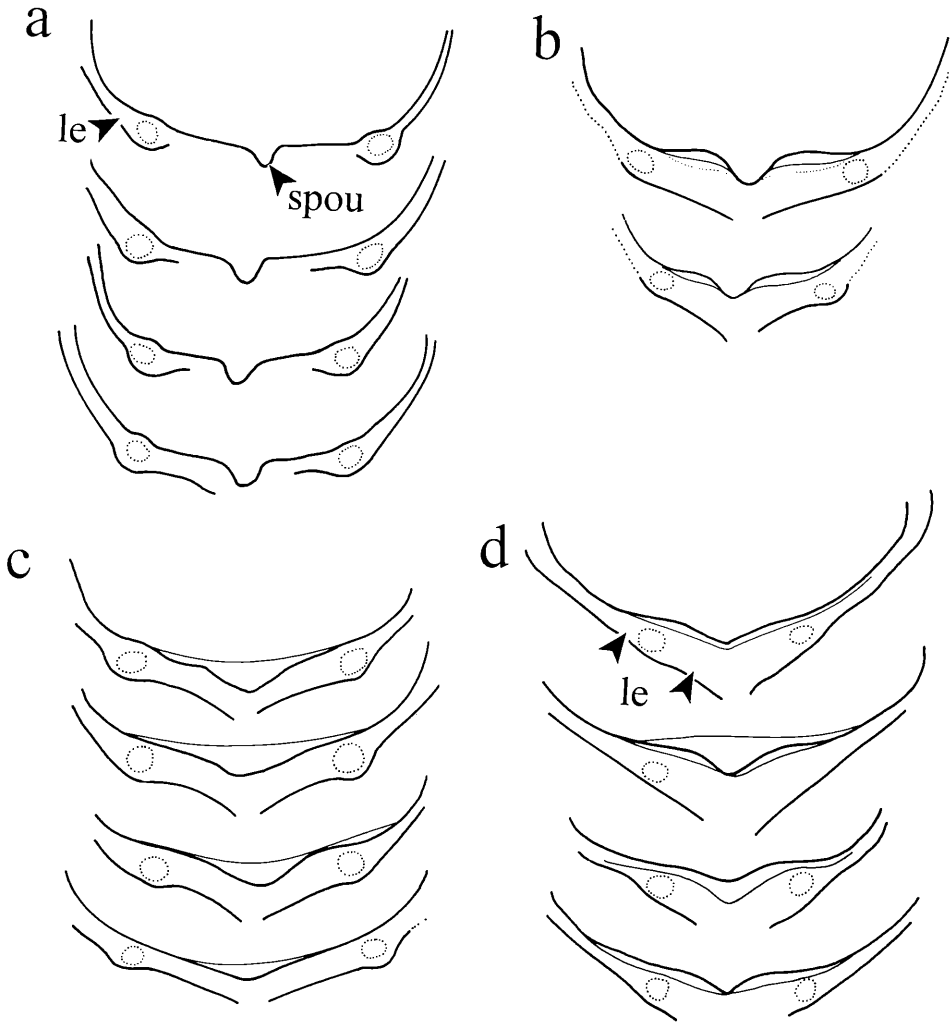


Fig. 12: Circumgnathosomal foramen with band le and spout like formation, examples to demonstrate variability: a) *Imparipes (S.) dispar*, b) *Imparipes (S.) kaszabi*, c) *Imparipes (S.) aricus*, d) *Imparipes (S.) schusteri* nov. spec.

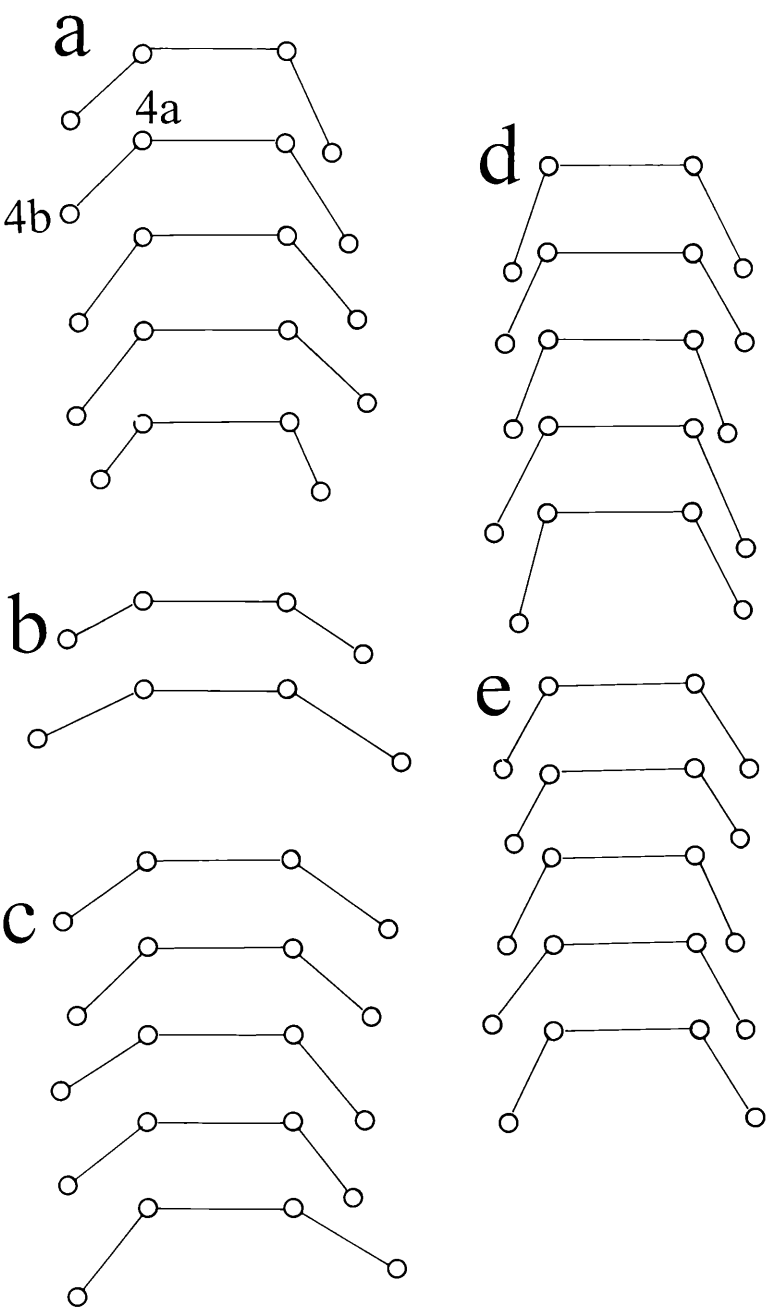


Fig. 13: Insertions of setae 4a - 4b, connected with lines for better understanding, examples of variability: a) *Imparipes (S.) dispar*, b) *Imparipes (S.) intermedius*, c) *Imparipes (S.) kaszabi*, d) *Imparipes (S.) aricus*, e) *Imparipes (S.) schusteri* nov. spec.

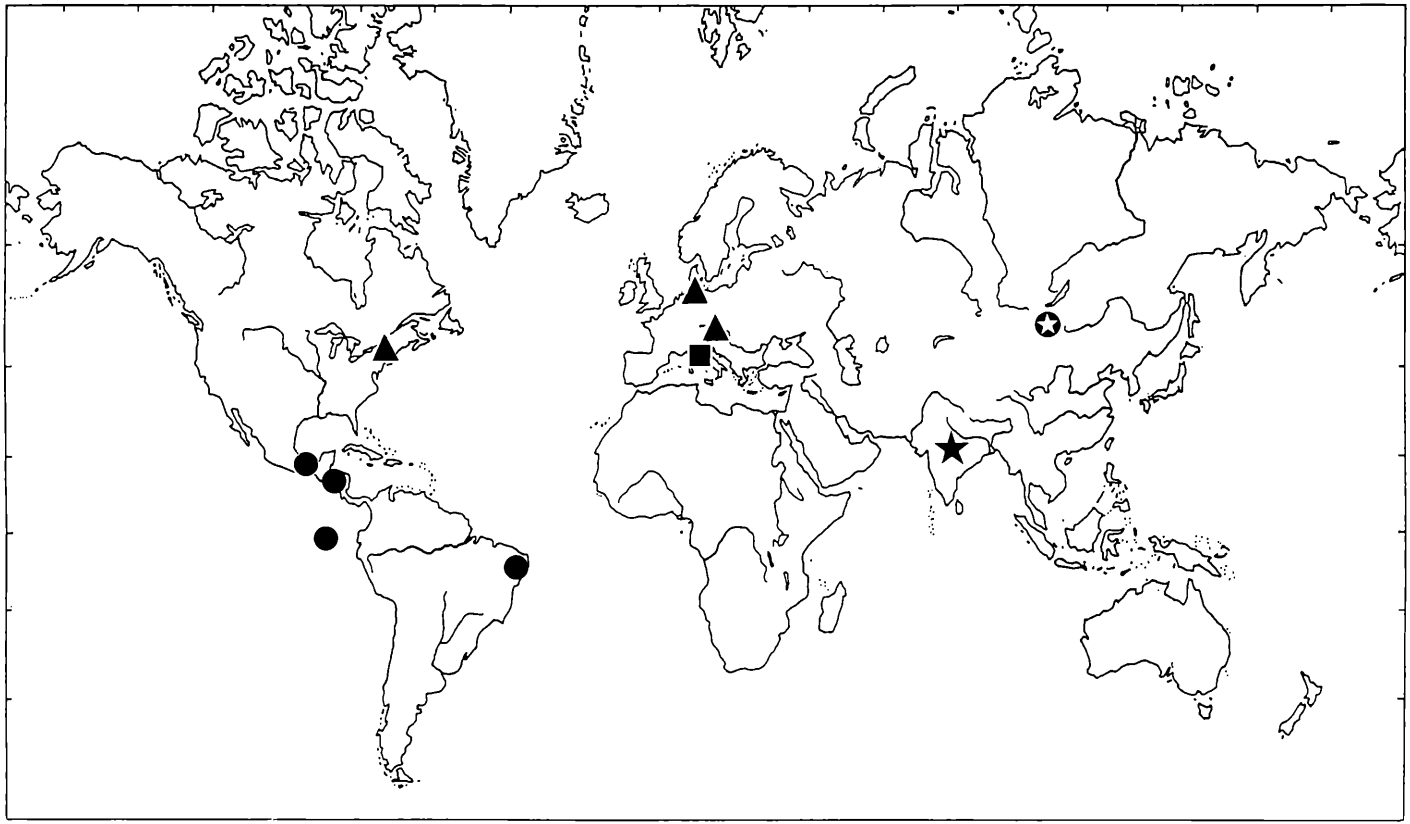


Fig. 14: Currently known distribution of the new subgenus *Sporichneuthes*:
▲ *Imparipes (S.) dispar* RACK, 1964: Germany, Austria; ■ *Imparipes (S.) intermedius* PAOLI, 1911: Italy;
✪ *Imparipes (S.) kaszabi* MAHUNKA, 1967: Mongolia; ★ *Imparipes (S.) aricus* MAHUNKA, 1971: India;
● *Imparipes (S.) schusteri* nov. spec.: Galapagos Archipelago, Mexico, El Salvador, Brazil.