

Redescription of *Willowsia jacobsoni* (Börner), an Entomobryid with Conspicuous Sexual Dimorphism (Insecta: Collembola)¹

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ABSTRACT

Sexual dimorphism is reported for the first time for the springtail *Willowsia jacobsoni* (Börner), this is the fourth record of conspicuous sexual dimorphism in the Entomobryidae. Typical males can be separated from typical females of the same age by the absence of pigment on the mesothorax, less abundant pigment on the fourth abdominal segment, and smaller size. These differences allow the separation of the sexes well before maturity. Aforementioned sexual differences apply to over 80% of the adults; few show variations which are discussed briefly. The species is redescribed on the basis of Puerto Rican specimens that represent the first record of the genus *Willowsia* from the Neotropical Region. The six proposed varieties of *W. jacobsoni* are discussed and considered as mere forms, although in a few cases that are pointed out they may represent different species. Head seta S_6 may be a macro- or a microchaeta or it may be a macrochaeta, on one side of the head and a microchaeta on the other side.

INTRODUCTION

April 5, 1979, I collected three entomobryids with a rather attractive color pattern consisting of three conspicuous dark bands interspersed by amber pigment (fig. 4). The specimens were kept in a culture jar and after a new generation was established, two of the original specimens were mounted on microscope slides for identification. They belong to the principal or main form of *Willowsia jacobsoni* (Börner) 1913, and represent a new generic record for the Neotropical Region.

The second generation included specimens of the main form and of Börner's var. *lipostropha*, also described in 1913, and characterized by the lack of pigment on the mesothorax (Th. 2) and by a narrower band on the fourth abdominal segment (figs. 1, 33). Mating experiments and studies of the genital areas demonstrated that this difference in pigmentation reflects sexual dimorphism where members of the main form are females.

Conspicuous sexual dimorphism among the entomobryids has been reported for only three of the more than 1400 described species. Stach (22, 23) pointed out that Uzel's European *Entomobrya dorsalis* and *E. puncteola* are, respectively, the males and females of a species with dimorphism in the color pattern. Males have dark blue-black pigment

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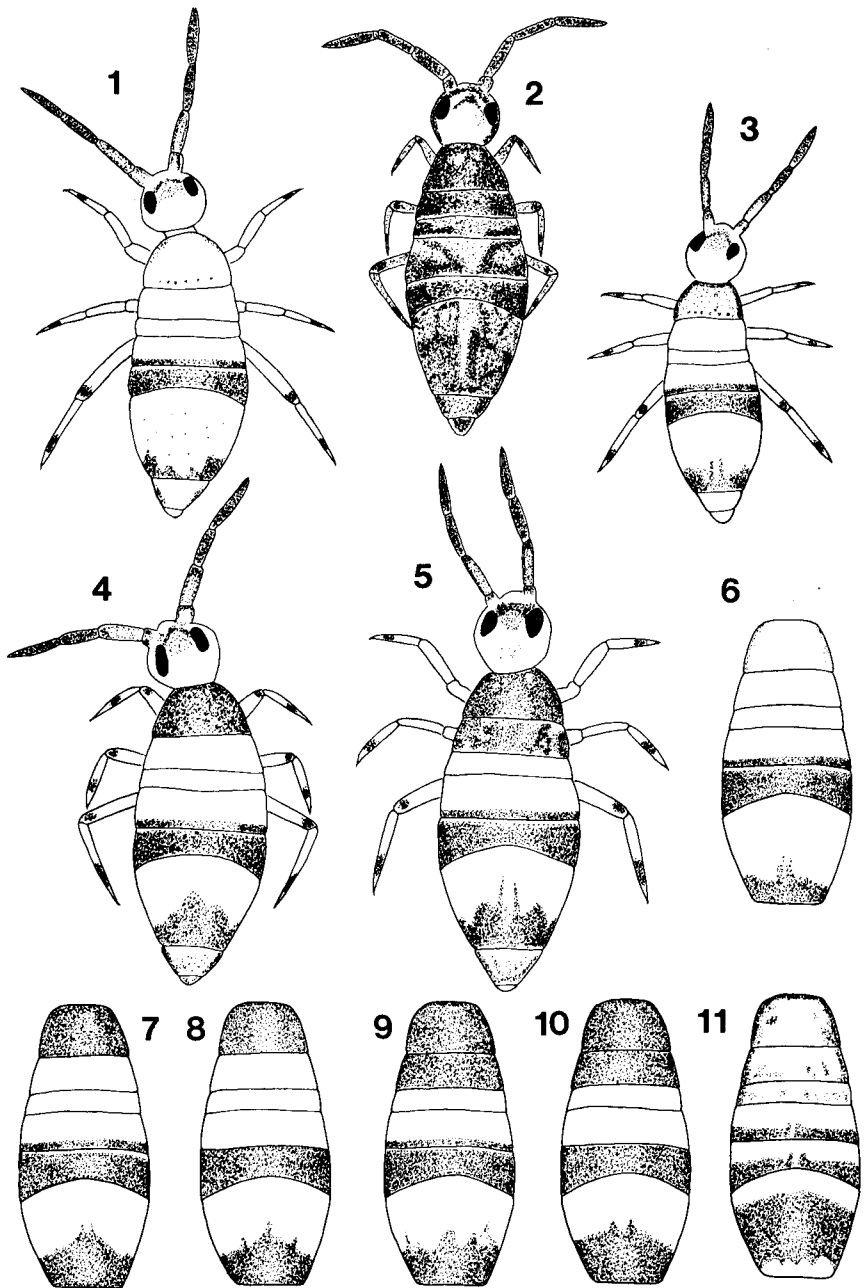


Plate I. Figs. 1-11.

1. Typical pigmentation of male (see also fig. 33). 2. Female with thoroughly pigmented body. 3. Male with lightly pigmented mesothorax. 4. Typical female. 5. Female with pigmented metathorax. 6-11. Pigmentation of the various proposed varieties (redrawn from Uchida (26) and Delamare Deboutteville and Paulian (5)). 6. var. *lipostropha*. 7. Main or principal form. 8. var. *tricineta*. 9. var. *handschini*. 10. var. *indica*. 11. var. *africana*.

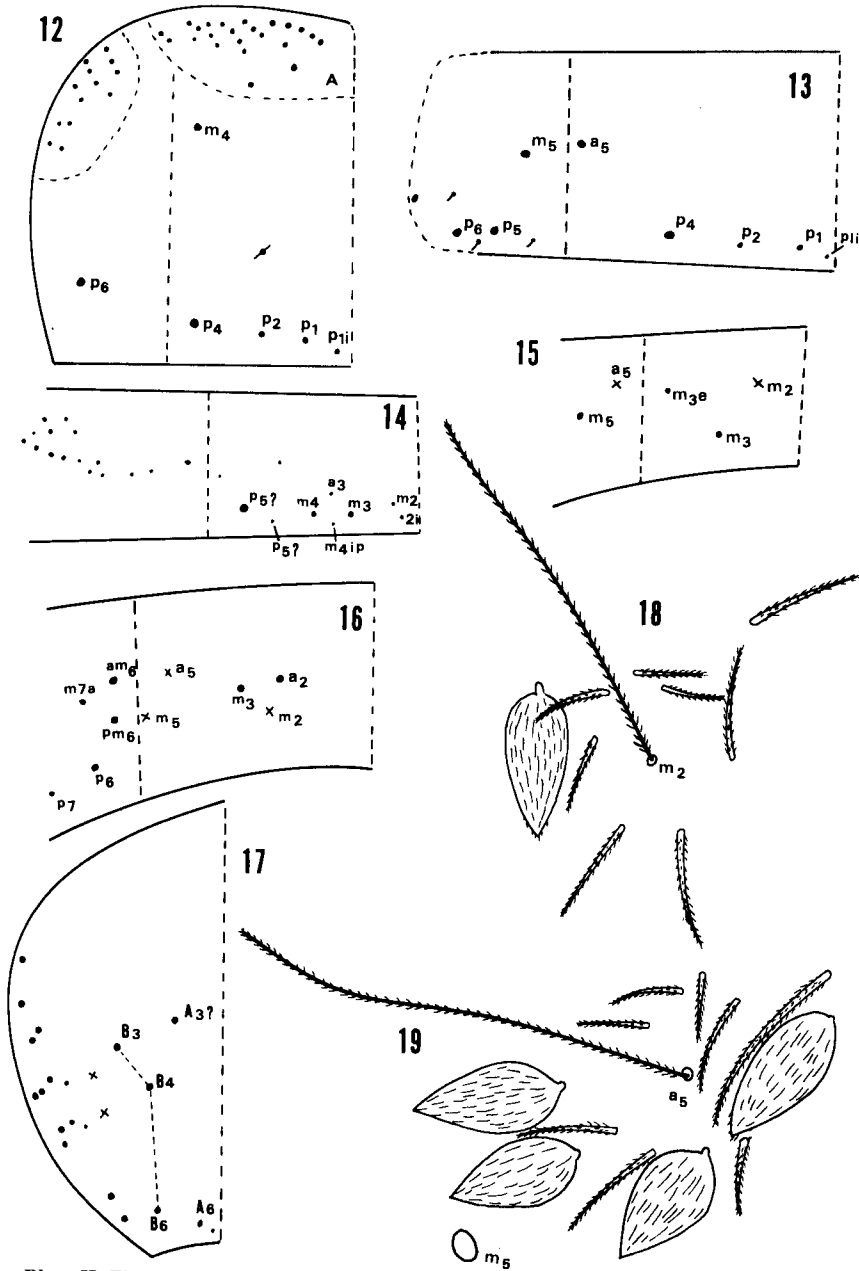


Plate II. Figs. 12-19.

12-17. Distribution of macrochaetae (larger dots), microchaetae (smaller dots), and trichobothria (x). The system of nomenclature is after Szeptycki (25). 12. Mesothorax (Th. 2). 13. Th. 3. 14. Abd. 1. 15. Abd. 2. 16. Abd. 3. 17. Abd. 4. 18. Trichobothrial complex of Abd. 2 around seta m₂. 19. Trichobothrial complex of Abd. 2 around seta a₅.

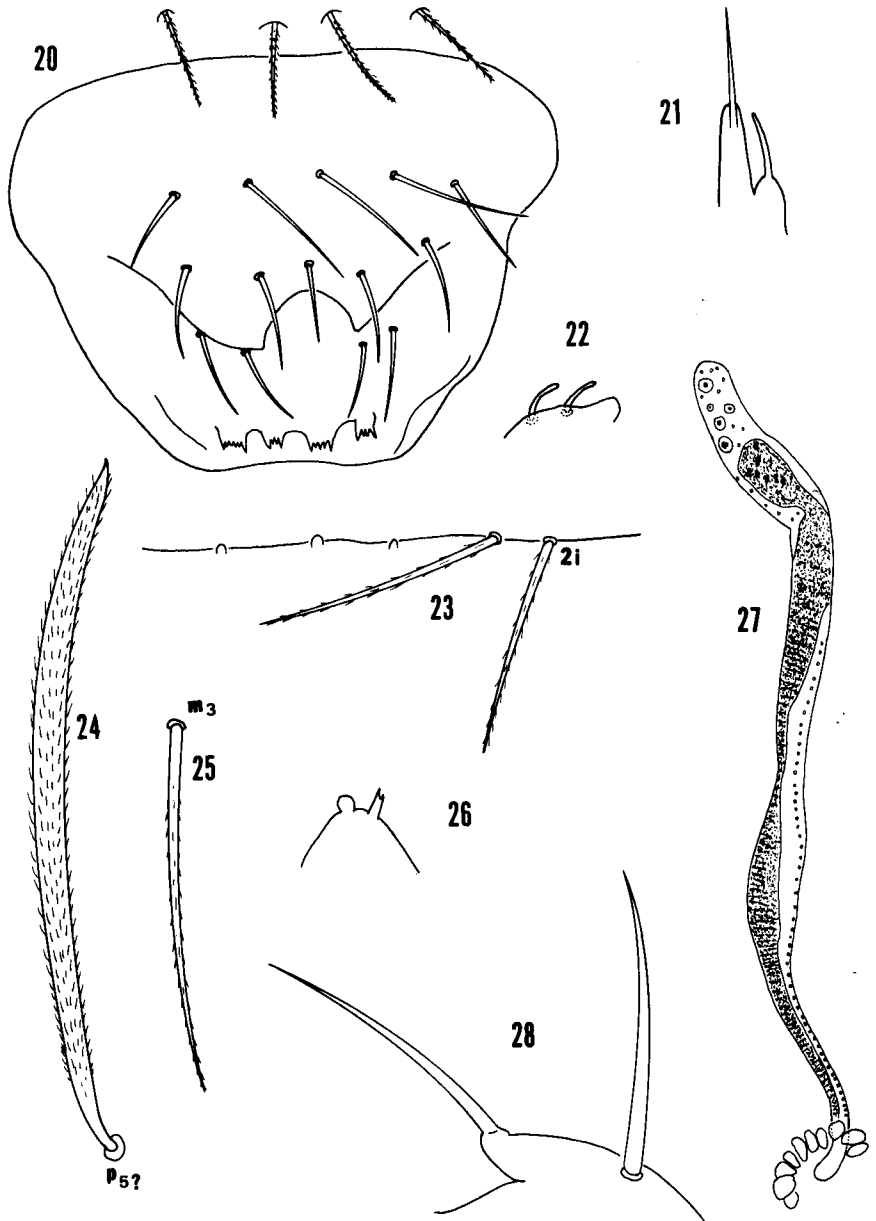


Plate III. Figs. 20-28.

20. Labral chaetotaxy. 21. Outer labial papilla and its differentiated seta. 22. Ant. 3 sense organ. 23-25. Setae of Abd. 1 (see also fig. 14). 23. Microchaetae. 24. Typical macrochaeta. 25. Second type of macrochaeta. 26. Apex of Ant. 4. 27. Ejaculatory duct. 28. Maxillary palp.

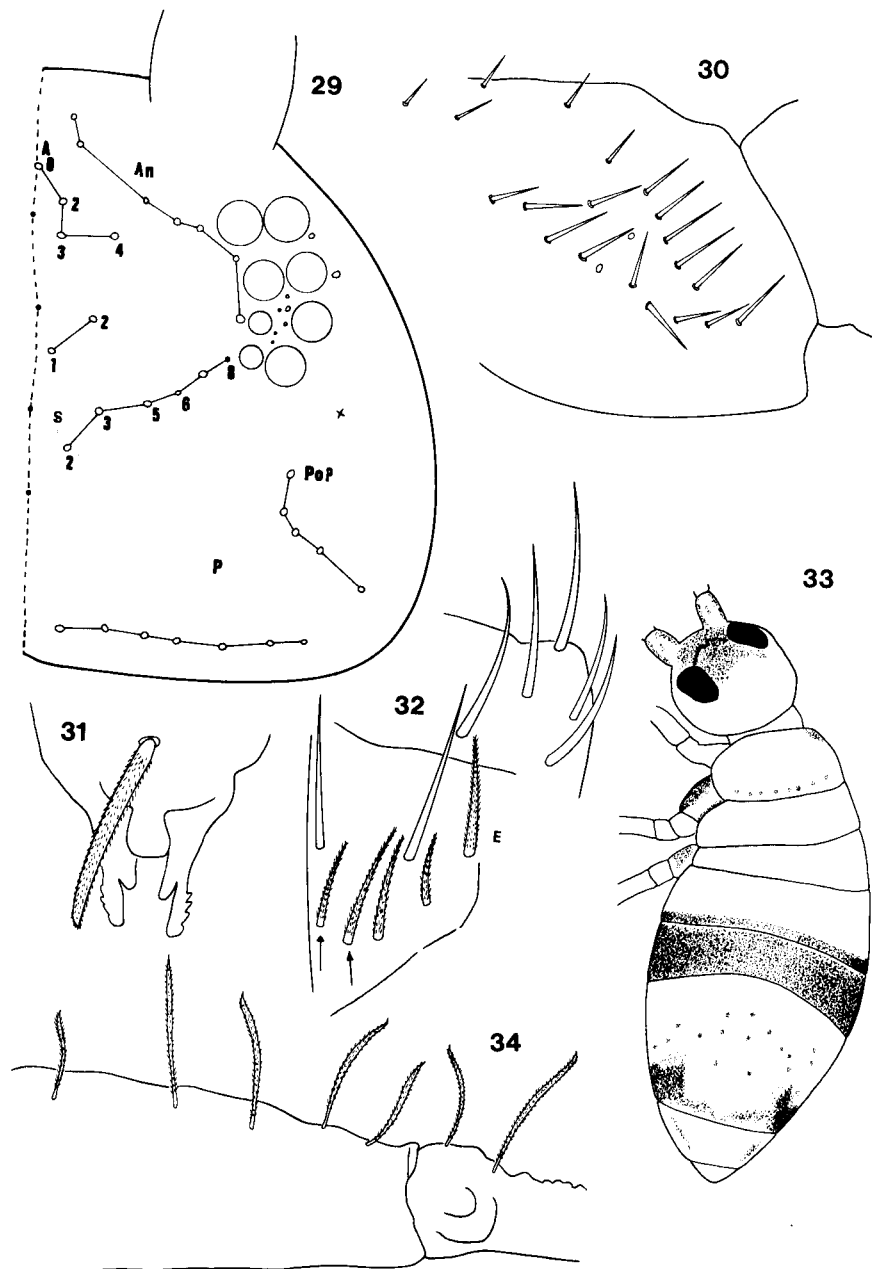


Plate IV. Figs. 29-34.

29. Distribution of macrochaetae (connected circles), some of the microchaetae (dots), interocellar setae, and the cephalic trichobothrium (x). The system for naming the head macrochaetae is after Mari Mutt (18). 30. Trochanteral organ. 31. Tenaculum. 32. Labial chaetotaxy, setae indicated by arrows are absent in most specimens. 33. Typical male (see also fig. 1). 34. Lateral view of manubrium and proximal portion of dentes showing the arrangement of one of the two parallel rows of macrochaetalike plumose setae.

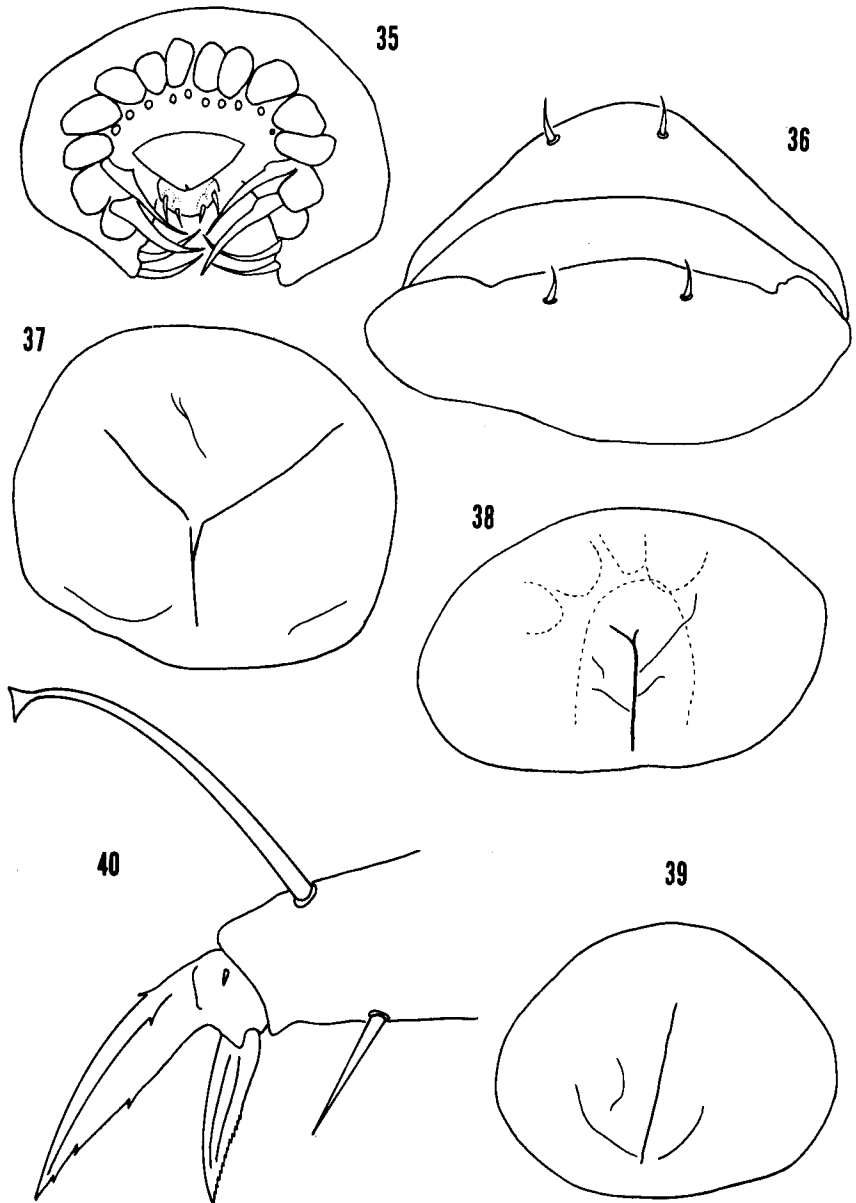


Plate V. Figs. 35-40.

35. Male genital plate. 36. Female genital plate. 37-39. Genital plates of individuals with the male pigmentation but lacking reproductive structures (fig. 27). 40. Metathoracic claws.

over most of the head, thorax, and fourth abdominal segment, whereas in the females the pigment is not as dark and more or less dispersed throughout the body (see Stach (23): plate XXXIV). The sexual dimorphism in *Entomobrya superba* (Reuter) is less distinct. The reader is referred to Stach (23): 100-102, plate XXXV.

Lindenmann (17) and Poggendorf (19) describe the sexual dimorphism of *Orchesella cincta* (L.). Here, the males possess patches of white hairs on different parts of the body during reproductive periods. At other times, and before maturity, the sexes are not distinguishable.

Stach (23) does not point out whether the sexual dimorphism he discovered occurs also in immatures. Pigmentation differences in *Willowsia jacobsoni* are established very early, and with some experience it is easy to distinguish the sexes well before maturity.

DESCRIPTIONS

Willowsia jacobsoni (Börner)

Sira jacobsoni Börner 1913: 49-52; fig. 4 (cotypes: Samarang, Java; Ricks Museum, Leiden). Handschin 1925: 237-238, 266, 268; figs. 12-16 (redescr.). Handschin 1928: 247, 266 (mention). Handschin 1929: 230, 240, 261 (n. var. *indica*). Denis 1929: 105, 106 (comp. *parajacobsoni*). Handschin 1932: 473, 481, 486, 487, 489; fig. 6 (descr. notes var. *indica*). Folsom 1932: 66-67; figs. 82-88 (redescr., diag.). Denis 1936: 266 (mention). Womersley 1937a: 156 (syn. *tricincta*). Womersley 1937b: 204, 205 (syn. *tricincta*, variab.). Handschin 1938: 143 (mention). Womersley 1939: 188, 189, 266, 271; fig. 60b (descr. notes, distr.). Denis 1941: 44, 45, 47, 48 (syn., key, distr.). Womersley 1942: 28 (record). Uchida 1944: 1, 4-6, 7, 18, 19, 20; fig. III 1-7, IV 1-5 (redescr., n. var. *handschini*, var. *tricincta*, syn., key, distr.). Delamare Deboutteville 1948a: 316, 420 (record with termites). Delamare Deboutteville 1948b: 38 (mention). Denis 1948: 184, 240-241; fig. 19a-e (variab., syn.). Zimmerman 1948: 58, 59; fig. 24a-g (descr. notes). Uchida 1949: 44 (distr.) Delamare Deboutteville 1951: 82; fig. 22a-c (n. var. *africana*). Delamare Deboutteville & Paulian 1952: 17, 27, 48, 73-76; figs. 34-44 (descr. notes, key distr.). Uchida 1955: 203, 205-206; fig. 3A-D (descr. notes, variab.). Uchida 1958: 13 (distr.).

Seira jacobsoni (Börner). Salmon 1964: 503 (refs.).

Willowsia jacobsoni (Börner). Stach 1965: 362 (n. comb.). Yosii 1966a: 48 (distr.). Yosii 1966b: 509 (mention). Yosii 1971: 120 (mention). Gapud 1971: 14, 16-18, 47; fig. 6A-F (redescr., variab., syn., distr.).

Sira tricincta Schött 1917: 31; fig. 37 (holotype: North Queensland, Australia). Womersley 1937a: 156 (syn. *jacobsoni*). Denis 1941: 47 (syn.).

Sira parajacobsoni Denis 1929: 105 (cotypes: Tamatave, Madagascar³).
 Denis 1936: 266 (mention). Denis 1941: 44 (syn. *jacobsoni*). Denis 1948:
 240 (syn.). Delamare Deboutteville 1948b: 38 (syn.).

Male

Length of adults 1.2-1.8 mm. Background color light yellow to amber with violet pigment distributed as in figs. 1, 33. Dorsum of head and body covered with striated brown fusiform scales that are absent from antennae, legs, collophore and furcula. Antennal ratios as 1:2.2:1.8:2.8; Ant. 2 consistently longer than Ant. 3. Apex of Ant. 4 with pin seta and rounded papilla (fig. 26). Ant. 3 sense organ of 2 apically rounded pegs (fig. 22). Head macrochaetotaxy and distribution of interocellar setae as in fig. 29; seta S_6 a macro- or microchaeta (see comments). Labral chaetotaxy (fig. 20) follows formula 5,5,4. Prelabral setae finely ciliated, inner pair close together. Labral papillae large, each with 3-7 teeth of variable size. Posterior row of labial triangle with 2 ciliated setae in addition to E, sometimes with 1 or 2 extra setae (i.e., fig. 32). Maxillary palp as in fig. 28. Differentiated seta of outer labial papilla as in fig. 21; not reaching apex of its papilla. All setae of venter of head ciliated. Trochanteral organ as in fig. 30. Tibiotarsi without smooth setae. Structure of claws as in fig. 40, outer lamella of unguiculus finely serrated upon distal half. Corpus of tenaculum with a ciliated seta (fig. 31). Body macrochaetotaxy as in figs. 12-17; two types of macrochaetae present (see comments). Trichobothrial complex of Abd. 2 as in figs. 18, 19. Abd. 4 dorsally about 4.5× length of Abd. 3. Genital plate⁴ (fig. 35) of the papillate type, large, occupying most of the venter of Abd. 5. Furcula without smooth setae; its dorsum with a double row of erect macrochaetalike setae arranged as in fig. 34. Dental spines absent. Mucro with 2 teeth and basal spine.

Female

With all the aforementioned characteristics of the male except: Length of adults 1.4-2.2 mm. Violet pigment distributed as in fig. 4. Genital plate as in fig. 36.

Material examined

The preceding descriptions are based on 35 males and 35 females reared at 30° C in cultures of a 9:1 plaster of paris-activated charcoal substrate. The specimens are descendants of three females I collected in

³ Dr. J.-M. Thibaud stated in a personal communication that he could not locate the types in the collection of the French Museum of Natural History, Brunoy.

⁴ To observe the genital plate, it is better to mount the specimen ventral side up with its furcula in resting position (pressed against the body). I clear the specimen until most of its pigment is removed.

Mayagüez at #224 on 11 de Agosto Street, April 5, 1979. These three specimens, and 24 individuals of an unidentified *Seira*, were collected with an aspirator while they were walking along a concrete fence in my backyard.

Geographic distribution

Java—Börner (1), Handschin (12,13); Sumatra—Handschin (13,15); Ceylon—Handschin (14); Vietnam—Denis (9); Cambodia—Denis (9); Philippine Islands, Luzon—Gapud (11); Micronesia, Mariana and Caroline Islands—Uchida (26); Marcus Island—Uchida (28); Hawaii, Oahu—Folsom (10); New Guinea—Womersley (31); Australia, North Queensland, Victoria—Schött (21), Womersley (33); Ivory Coast—Delamare Deboutteville (2), Delamare Deboutteville and Paulian (5); Madagascar—Denis (6); Puerto Rico—**new record**.

COMMENTS

CONSTANCY OF SEXUAL DIMORPHISM

Although more than 80% of the males and females exhibit the typical pigmentation described above, a small but consistent number of individuals present the following variation. Some males (fig. 3) have a lightly pigmented mesothorax and hence resemble females but they can usually be separated from the latter by the male's smaller size and less abundant pigmentation on Abd. 4. Unusually large (over 1.6 mm) specimens with the typical pigmentation of the male sometimes lack the male genital plate and associated reproductive structures (fig. 27). These specimens seem to be abnormal sterile males since their genital plate (figs. 37-39) is unlike that of the female.

Some females have a sparsely to thoroughly pigmented metathorax (fig. 5; c.f. var. *handschini* Uchida (26)) and the whole body is more or less thoroughly pigmented in other females (e.g. fig. 2; c.f. Uchida (26): 5, fig. IV 5).

All the aforementioned variation can be found in any fairly large colony (about 600 specimens) but it remains unknown whether the frequency of these phenotypes is determined genetically, by environmental factors (e.g. temperature) or by a combination of these.

The intensity of the background color depends on the concentration of light to dark amber-colored microscopic granules. These granules seem to be present in the fluids or loosely tied to tissues (fat body?) underlying the cuticle, since specimens kept in Marc André II mounting medium that is dried at 52 ° C for 24 hours, lose the granules and their yellow color. Males tend to concentrate more of these granules than females do. Violet pigment is also due to microscopic granules, but these are not removed by the aforementioned preservation techniques.

STATUS OF THE SIX PROPOSED VARIETIES

Figures 6–11 (redrawn from Uchida (26): 5, fig. IV 1–5 and Delamare Deboutteville & Paulian (5): 75, figs. 40–44) detail the differences in pigmentation that characterize the purported six varieties of *Willowsia jacobsoni*. These are considered herein as forms or morphs of the same species, but as implied below, further studies are required to determine whether all these varieties are mere forms or whether a complex of closely related, perhaps sibling, species is involved.

The pigmentation of the main form and of var. *lipostropha* Börner 1913 represents the usual or typical pattern of the female and male. Both forms have been collected sympatrically in Java—Börner (1), Micronesia—Uchida (26), Vietnam—Denis (9), Madagascar—Denis (6), Ivory Coast—Delamare Deboutteville & Paulian (5), and apparently also in Australia (Womersley (30): 205 states “and in two specimens . . . which were apparently immatures, only lateral pigmentation was present on the meso- and metathorax”). This is the pattern expected for males).

Several specimens with the pattern of the Javan var. *handschini* Uchida occur in my cultures but no specimens have been found with the pigmentation of var. *indica* Handschin 1929 (Ceylon, Sumatra), which differs from *handschini* only in the absence of pigment on Abd. 2. While Puerto Rican specimens with the *handschini* pigmentation are females, Handschin ((12): 237, fig. 6) presents a male genital plate for his specimen. This may represent an abnormality not yet detected in my cultures or perhaps Handschin’s specimen represents the males of a closely related undescribed species.

Schött (21) described the new species *Sira tricincta* from a specimen collected in North Queensland, Australia. Womersley (30, 31) synonymized the name to *W. jacobsoni* but Uchida (26) and Delamare Deboutteville & Paulian (5) used *tricincta* for a variety distinguished from the main form by the absence of pigment on Abd. 2 (i.e., the same difference as between *handschini* and *indica*). No specimens corresponding to this form have been detected in my cultures.

The variety *africana* Delamare Deboutteville 1951 from Ivory Coast differs from the other forms by the absence of the mucronal spine (Delamare Deboutteville (4): 82, fig. 22b) and by the pigmentation. Its color pattern has not been detected in my cultures and *africana* could represent a different species. The variety was established for a specimen collected together with a male and female with the typical pigmentation.

CHAETOTAXY

The head macrochaetotaxy (fig. 29) exhibits an interesting variation. Seta S_6 (the system for naming the macrochaetae is after Mari Mutt (18))

may be a macro- or a microchaeta; a female was found with a macrochaeta on the left side of the head and a microchaeta on the right side. When S_6 is a macrochaeta, it is of the usual plumose type (fig. 24) but it is only about half the length of the other S setae and the diameter of its socket is correspondingly smaller. Head macrochaetotaxy is otherwise constant in both sexes.

Figures 12-17 illustrate the distribution of macrochaetae and some of the microchaetae. I have used Szeptycki's (25) system of nomenclature for those setae that I could homologize with some confidence, following his drawings for several species of *Willowsia*. Two types of macrochaetae are found on the body. The first type (fig. 24) is the regular long plumose macrochaeta. The second type (fig. 25) is a much shorter lightly ciliated and apically pointed seta which is really not much different from microchaetae (fig. 23), although the diameter of their sockets is larger than that of the small setae.

RESUMEN

Por primera vez se cita la existencia de dimorfismo sexual en el colémbolo *Willowsia jacobsoni* (Börner). Ésta es la cuarta especie de la familia Entomobryidae que presenta un dimorfismo sexual evidente. Los machos con coloración típica se diferencian de hembras típicas de su misma edad por la ausencia de pigmento en el mesotórax, menos pigmento en el cuarto segmento abdominal y por su menor tamaño. Estas diferencias, que permiten distinguir ambos sexos mucho antes de la etapa adulta, se aplican a más del 80% de los adultos; un porcentaje bajo presenta variaciones que se discuten brevemente. La especie es redescrita a base de ejemplares puertorriqueños que representan la primera cita del género *Willowsia* para la Región Neotropical. Se incluye y se comenta brevemente toda la literatura sobre esta especie. Se discute el status de las seis variedades de *W. jacobsoni*, las que se consideran como meras formas, aunque se indican algunos casos que pueden representar especies diferentes. La seda cefálica S_6 puede ser una macro- o microseda o puede ser una macroseda en un lado de la cabeza y una microseda en el otro lado.

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