THE DEUTEROPHLEBIIDAE OF JAPAN

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THREE PLATES

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In April 1926 a number of curious larvae and pupae of an insect were found by the author in a torrent at Kurama near Kyôto. They lived attached to the surface of rocks in intimate association with Blepharocerids. It could not be made out at first to what group they should be referred. After consulting Professors T. Kawamura and H. Yuasa of the Kyôto Imperial University, it became clear that similar insects had been described some years ago by F. W. Edwards (1922) and N. Pulikovsky (1924) as *Deuterophlebia mirabilis* Edwards and *Deuterophlebia* sp. respectively. At the general meeting of the Zoological Society of Japan held in Tôkyo in April 1929 I reported on the larva, pupa and female imago of this newly discovered Japanese Deuterophlebiid.

The first description of *D. mirabilis* by Edwards was based upon two male specimens collected in Kashmir at about 11,000-12,000 feet above the sea-level. The second description by Pulikovsky relates to the larva, pupa and female imago extracted from pupa collected in the Altai Mountains. R. A. Muttkowski (1927) reported the occurrence of the larva and pupa from Yellow-Stone Park, U. S. A., and K. Brodsky (1930) studied the structures of the larva, pupa and extracted imago from Central Asia. The larva and pupa of our species were first illustrated by Prof. Kawamura (1932) in "Nippon Konchu Zukan" (Monograph of Japanese Insects) as *Deuterophlebia* sp. Mr. S. Yie studied the same from a torrent at Kurama during 1932-33 and reported on its habitat and metamorphosis, calling the insect a Japanese form of *Deuterophlebia*. The grave difficulty in identifying this insect was due to the rareness of the male on which sex the original species had been described. Since 1926 I have made continuous efforts to obtain not only the male imago but also all different stages of development, till at last in 1937 I obtained numerous materials which have

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led me to the establishment of two new species of the genus *Deuterophlebia*. One of them is widely distributed in various parts of the Honsyû and Kyûsyû while the other is a resident of the streams in Central and Northern Tyôsen (Korea).

In giving here the descriptions of our Deuterophlebiids, I wish to acknowledge my great indebtedness to Professor Tamiji Kawamura for his kind advice and supervision throughout this work. Hearty thanks are also due to Professor Dr. Hachiro Yuasa and Professor Dr. Teiso Esaki for their kind helps and advices to my work. I acknowledge also the kindness of Mr. Shi-tao Yie in giving me a reprint of his important article.

DEUTEROPHLEBIA NIPPONICA SP. NOV.

MALE (3 specimens extracted from mature pupae)

Head (figs. 1, 2): rather small, transverse and flat, entirely hidden under the projecting mesonotum. Eyes rather small, entire and subspherical, without bristle or pubescence; facets brownish black, all of similar size. Ocelli absent. Middle lobe of clypeus slightly prominent, with a number of very short bristles; lateral margins of clypeus set with dense fine hairs. Mouth-parts entirely reduced, but the mouth is present on the under side of the middle lobe of clypeus. An area behind the mouth and pocket-like depressions is slightly depressed, its margin is fringed by a chitin band. Occipital foramen very large. No distinct neck.

Antennae: six-jointed, slender and very long, measuring 10.8 mm. in length. The first five joints together are not much longer than the breadth of the head and measure 0.77 mm., but the last joint is more than three times as long as the whole body and about 10 mm. in length. Scapal segments absolutely bare, very thick; proximal one more than twice as long as the second and considerably broader; distal one cup-shaped, slightly shorter than broad. First flagellar joint cylindrical, slightly longer than the two scapal joints put together, distal inner margin near the tip very slightly prominent and with about ten short bristles. Second and third flagellar segments subequal in length and together as long as the first; each nearly cylindrical, but the inner side beyond the middle is considerably prominent, and the outer side slightly concave. The inner prominences are pale, each with a tuft of about ten short, stiff, pale bristles; no hairs on the rest of these segments.

The terminal segment (fig. 1, a, b) is very gradually tapering towards the tip, its basal portion nearly as thick as the preceding segment, but the apical portion is very slender, being scarcely one-fourth or one-fifth as thick as the basal portion; the tip of the segment is considerably swollen and club-shaped. The outer side of the segment is chitinised, blackish and absolutely bare, but the inner side is slightly chitinised, undulated, and set with slender fine hairs. The hairs are very closely set on the proximal one-third of the segment which is very finely undulating; on the middle one-third more or less sparse, and tend to be confined on several swellings. Apical one-third of the segment is mostly glabrous, except for a few swelling portions as well as the club-shaped apex which are sparsely setaceous.

Thorax: entirely glabrous, blackish brown. Prothorax very much reduced, its notum and pleurae are nothing but a chitin band fringing the occipital foramen. Mesontum very conspicuous and convex. Praescutum paraboloidal, extending forwards over the head, with a median longitudinal black stripe which extends to the hind end of scutum. Scutum laterally separated from the praescutum by a pair of black sutures, but the median portions of these sclerites are contiguous. Divisions between the scutum, scutellum and postscutellum are quite distinct. Scutellum rather flat and transversely quadrilateral. Postscutellum very large, with the full breadth of the mesonotum. Metanotum small, mostly hidden under the tergites of first two abdominal segments. Pleurae of mesothorax of simple structure, mainly facing ventrally; pleural suture distinct, episternum rather smaller than epimeron. Prosternum very small, transverse. Mesosternum flat, rather large. Metasternum semicircular, convex forwards. Prothoracic and metathoracic spiracles large, oval, fringed by chitin band.

Wings (fig. 12): Length about 4.7 mm., breadth about 2.3 mm. Very large for the size of the body, very broad, with a conspicuous anal lobe. Macrotrichia very slender and delicate, confined on the posterior margin of the wing; the hairs are rather long and dense on the wing base and anal angle, but shorter and sparse towards the apex, vanishing in the third "secondary cell" near the apex. Microtrichia dense, clearly distinguished under a high magnification ($\times 300$) as short hairs, which are slightly longer and curved on the wing margins. Vestiges of veins: Costa slightly thickened and darkened, almost attaining the wing apex; Sc rather obvious, terminating at the middle length of the wing; Radius obvious at the base, but R_1 and R_S faint, each terminating in costa; Media rather distinct, but not attaining the

wing margin; Cu and An scarcely preserved on its base. Secondary venation obvious, and of fan-like arrangement, with three concentric lines, besides two rather dark transverse lines in the middle of the wing. Details of the secondary venation slightly differ, not only individually but also in the wings of the same specimen. Halteres pale greyish, with very minute pubescence; the stem slender and dorsally curved; the knob subspherical.

Legs (figs. 3–6): slender, measuring as follows:

	Femora	Tibiae	Tarsi
Fore-legs	0.62 mm.	0.9 mm.	0.94 mm.
Mid-legs	0.52 mm.	0.7 mm.	0.92 mm.
Hind-legs	0.67 mm.	0.9 mm.	0.70 mm.

Legs: Coxae both more than two times as long as broad, set with microscopical pubescence; front pair slightly thickened apically; hind pair rather stouter than the others. Trochanters nearly as long as the coxae, but more slender, microscopically pubescent, being two-jointed obliquely, distal joint much slender. Femora nearly cylindrical, sparsely set with short setae on the extensor surface; front pair a little stouter than the others; middle pair shorter and thickened proximally.

Tibiae all longer than femora, very slender proximally, but more or less thickened distally; densely set with very fine, pale, erect, apically knobbed hairs mainly on the flexor surface. Front tibiae densely setaceous on the distal 3/4 of the flexor surface as well as on the distal 1/5 of the extensor surface, but very sparsely on the rest of the segment. Middle tibiae considerably swollen on the distal 1/3 of the flexor side; densely setaceous on the distal 1/2 of the flexor surface as well as on the distal 1/5 of the extensor surface. Hind tibiae densely setaceous on the flexor surface only. No trace of tibial spurs.

Tarsal segments of all legs densely set with fine, pale, erect, apically knobbed hairs on each flexor surface, but the extensor side entirely bare. The hairs are similar to those of the tibiae, and about as long as the diameter of each segment. First tarsal segment of all legs cylindrical, very slender; in front legs nearly one-half as long as the tibia, and almost as long as the following segments put together, which are about equal in length and obliquely articulated; in middle legs about 3/5 the tibia, and nearly as long as the following segments together; in hind legs shorter than 1/4 the tibia and scarcely as long as the following two segments together. The last tarsal segment (fig. 6) of all legs

slightly enlarged apically, and very sparsely set with knobbed hairs. Empodium very large, nearly circular, very densely set with yellowish, straight, knobbed hairs. The claw is slender, nearly straight and apically pointed, longer than the radius of the empodium; the second claw is much reduced to a small blunt prominence.

Abdomen (figs. 7, 8): broad at the base, tapering apically; dorsal side obscure yellowish brown, ventral less intense. Tergites rather feebly chitinised, with ill-defined obscure markings and a few transparent punctures; densely covered by microscopical pubescence. First and second segments pale; third segment still small. Seventh segment nearly as long as the preceding one, but very much decreased in width. Eighth segment very small, about one-half as long as broad; its tergite much reduced to a mere ring, but more strongly chitinised than the preceding ones; its sternite also rather strongly chitinised and set with several short hairs laterally. No spiracles in the abdomen. Sixth and seventh segments each with a blunt conical prominence on either side. The prominence is furnished with five or six, short, stiff bristles apically. Similar bristles are scattered in a transverse row so as to connect the prominences of both sides. Several bristles near the prominence arise each from a small papilla.

Hypopygium (figs. 7, 8): very simple, dull blackish brown. Ninth tergite fused with the tenth; anterior margin of the plate rather strongly concave, with a small median projection. Posterior part of the plate (tenth tergite) slightly bilobed laterally, or with a broad V-shaped apical emargination; each lobe rather densely set with short fine setae. Ninth sternite laterally fused with the dorsal plate (mainly with the ninth tergite). The sternite is thick, of inversed V-shape or bluntly pointed anteriorly and deeply concave posteriorly; mainly glabrous except for the postero-inner margins being slightly setaceous. Dorsal portion of the sternite with a narrow extention directed inwards. Claspers simple, nearly flat, but slightly convex on the outer side, set with short curved hairs on the flexor surfaces. Aedeagus simple, chitinised, tube-like, nearly three times as long as broad.

FEMALE (57 specimens)

Length of body about 1.8 mm., breadth of abdomen about 0.7 mm. Length of wing about 3.7 mm., breadth of wing about 1.8 mm.

Head (figs. 9, 10): nearly similar to that of the male in shape, but much smaller in size. Dorsal side brownish black, ventral much lighter. Eyes as in the male, brownish black. Clypeus with a setaceous, rather

eminently projecting middle lobe, but reduced lateral lobes. No trace of mouth-parts. Mouth opening obvious, nearly circular.

Antennae (fig. 11): slender and very short, about 0.4 mm. in length, but 6-segmented as in the male. Color light brownish to pale, except for the first scapal joint rather darkened. First scapal joint cylindrical, but much narrowed at its base; nearly three times as long as the second, which is very slightly longer than broad. First flagellar joint very slender, cylindrical, about as long as the following two segments together. Last three segments of about the same length, each nearly two times as long as broad. Flagellar segments each microscopically pubescent, and set with several short, stiff, pale bristles on its inner side near the tip, of which first segment with only one or two bristles.

Thorax: much similar to that of the male, mainly brownish black, entirely glabrous. Praescutum and scutum of mesothorax almost black, smaller and less conspicuously projected than in male.

Wings (fig. 12): as in the male, except for the anal lobe obtuse and the whole membrane somewhat opaque. Halteres as in the male.

Legs (figs. 13–16): slender, the length of which nearly equal to each other, measuring as follows:

	Femora	Tibiae	Tarsi
Fore-legs	0.53 mm.	1.14 mm.	0.74 mm.
Mid-legs	0.54 mm.	1.04 mm.	0.74 mm.
Hind-legs	0.61 mm.	1.11 mm.	0.72 mm.

Coxae much thicker than those of the male, those of front pair nearly as long as broad, hind pair nearly twice longer than broad; all microscopically pubescent. Trochanters two-segmented, much more slender than coxae, pubescent. Femora much stouter than those of male, nearly cylindrical, very sparsely set with short bristles on each extensor surface. Tibiae all about two times as long as the femora, much slender in proximal half, but gradually and slightly thickened distally, those of hind pair rather eminently curved, concave on the extensor side; rather densely set with fine hairs mainly on the extensor surface, as well as with sparse bristles. No trace of tibial spurs.

Tarsal segments of all legs with two or three, short, stiff bristles on the flexor surface near the tip, and with rather dense pubescence on both sides. First tarsal segment of all legs fairly longer than the second. Second to fourth segments subequal, nearly rhomboidal,

articulated obliquely. Last tarsal segment (fig. 16) of all legs about as long as the preceding three segments together, fairly thickened apically, the tip with several short bristles on the extensor surface and a small condylus on the flexor side. Claws paired, identical, stout and curved, each with a conspicuous thickening on its inner base. Empodium thin and long, more than two-thirds the length of the claw, densely setaceous.

Abdomen (figs. 17, 18): very broad, broadest in the middle, then tapering apically; densely set with microscopical pubescence. Dorsal integument obscurely yellowish brown, ventral less intensely. Tergites feebly chitinised, with ill-defined blackish brown markings and several transparent punctures on the median portion. First segment much reduced, pale; second pale, still smaller; fourth the broadest of all. Sixth and seventh tergites each with a coarse transverse row of short, blackish bristles near the posterior margin; conical prominences present on the seventh segment only. Seventh sternite darker than the others; eighth segment pale, nearly as long as the seventh, but its sternite entirely reduced.

Hypopygium (figs. 17, 18): simple, pale, with microscopical pubescence. Ninth tergite distinct, shorter than broad. Tenth tergite laterally bilobed, or with a broad V-shaped apical emargination (Gonapophysen, Brodsky), the apex of each lobe sharply pointed and slightly curved outwards. Ninth and tenth sternites fused into an oblong plate (subgenitale Plättchen, Brodsky), which has a semicircular apical emargination and very slight median longitudinal groove; the apices of the plate very dully pointed.

PUPA (numerous specimens) (figs. 19–22)

Body strongly flattened, rather broadly oval, outer margin undulated. Dorsal integument obscure blackish brown, ventral side light, but dark in mature specimens. Sexual dimorphism obvious, not only in the size and shape of the body, but also in the features of the organs on the ventral side.

Measurements: The size of the pupa varies rather remarkably in different seasons. Mr. Yie recorded a 3.3×2.4 mm. female-pupa from Kurama in January 1933, while I measured a female-pupa 2.0×1.4 mm. from Kurama in May 1929. The pupa is also sexually dimorphic in size. The male-pupa is always slightly larger than the female-pupa as shown in the following table:

Locality	Date	No. measured	Max. size	Min. size	Average
Tomoti	5. IV. '37	♂ 1			2.9×2.0 mm.
		♀ 1			2.5×1.8 mm.
Kurokawado	20. VI. '37	♂ 15	2.8×1.9 mm.	2.5×1.6 mm.	2.7×1.8 mm.
		♀ 36	2.7×1.9 mm.	2.3×1.5 mm.	2.6×1.7 mm.
,,	1. VIII. '37	♂ 5	2.7×1.8 mm.	2.5×1.7 mm.	2.6×1.8 mm.
		♀ 2	2.5×1.8 mm.	2.2×1.7 mm.	
,,	31. VIII. '37	♂ 1			2.3×1.7 mm.
		♀ 1			2.1×1.4 mm.

Segmentation: The head is located on the ventral side of the body; it is much larger in male than in female. The prothorax is entirely reduced, or fused with the mesothorax (in Blepharoceridae its vestige is preserved just behind the head). The mesothorax is conspicuous, nearly equilateral-triangle in dorsal aspect, but rather small and much shorter than broad in female. Anterior portion of mesothorax is partly faced ventrally, and partly projected forwards and upwards, forming the anterior end of the body which is bluntly pointed. A longitudinal seam which enables the imago to emerge, passes on the whole length of the median line of mesothorax. Metathorax very small, and does not attain the lateral margins. First and second abdominal segments both very narrow before and behind; lateral margins slightly projected forwards, forming a small prominence with spinelets. Fourth abdominal segment as broad as the body. Seventh the hind-most, with posterior margin slightly projected inwards, forming a small prominence with spinelets. Eighth very small, entirely enclosed by other segments. Ninth abdominal segment entirely fused with the tenth, its posterior margin free, with a pair of small projection directed inwards in male-pupa.

Granulation: Dorsal integument chitinised, with granules of three classes: (1) microscopic microgranules, dark brown in color, densely distributed on the whole of abdomen; (2) granules of moderate size, sparsely and irregularly distributed on the abdomen, except the last two segments; (3) transverse chitin bands and a few macrogranules distributed regularly. Mesothorax with three bands on each side of the raphe, of which first two are short, the third very long, more than two-thirds as long as the breadth of that part of the segment.

Metathorax with a pair of bands which are longer than one-third the breadth of the segment. Abdominal segments each with a pair of short bands and macrogranules. The band is very short in male pupa. The macrogranule is composed of several subcircular granules very closely set. The integument of the head and mesothorax is very slightly crumpled.

Respiratory horns: composed each of a short, thick stem and three much crooked filaments, the curvature being nearly similar in all specimens; the third filament zigzag-like with four arms in different directions. The stem is dark brown, filaments light brown.

Dorsal to the base of each respiratory horn is a conical prominence, which is nearly semicircular and chitinised, blackish, but with no thorns or spines.

Spinelets: fonnd on the lateral projections of the first and second abdominal segments as well as on the lateral margins of the sixth and seventh abdominal segments. They are very sharp and blackish brown; on the sixth segment more or less sparse, mostly found on the ventral deflection of the tergite.

Ventral surface (figs. 20, 22): Antennal sac very different according to sex; in male, very conspicuous, each forming two large elliptic rings lying on the ventral surface and concealing the great part of the body. In female, very short, elongate conical, scarcely attaining the base of wing-sac. Wing-sacs tongue-like, ending near the posterior margin of the fourth abdominal segment. Leg-sacs: Femoral portions directed antero-laterally; succeeding portions directed backwards, that of front-legs being inner-most and terminating fore-most, hind-legs outer-most and terminating hind-most. Tips of the leg-sacs of male swollen and knob-like, owing to the large empodium. Adhesive pads blackish, elliptic, resembling those of the Blepharoceridae.

LARVAE OF DIFFERENT STAGES

As to the larval stages, I am of the opinion that there are four instars in this family, though some different opinions have been published. It is of great importance to get hold the best available characteristics of each larval stage. The size of the body varies considerably, so that it does not afford a good criterion for this purpose. Indeed, the length of the body in every stage is nearly doubled in the next interval as I have seen in the Blepharocerid larvae. But just after moulting, specimens may often be smaller than

the younger instars before moulting. On the contrary, the number of the clawlet rings in the proleg (figs. 26, 28, 30, 33), and the relative size of the segments of antenna (figs. 25, 27, 29, 33) are fairly constant for each stage. This is just the case in the larvae of Blepharoceridae, concerning the number of the filaments in the segmental gill-tufts and of the joints in antennae.

The development of the larvae of this family is rather speedy, as Mr. Yie observed at Kurama in the summer of 1932; he describes "the larval period is passed in about 2 weeks." I have met with many specimens in several stages which are already forming yellowish to blackish rings of clawlets of the next stage under the integument of each proleg. In such cases, we can count the numbers of the rings of clawlets of the successive two stages exactly (figs. 28, 30). Determination of the stages of larva based upon the evidences above mentioned is in the following table:

Stages	Rings of claws	Antennal segments	Length of body
iv	9—12	1 : 1 : 2—3	2.8—4.3 mm.
iii	6—8	1 : 2—2.5 : 4—5	1.5—3.0 mm.
ii	3	0 : 1 : 2—2.5	1.0—1.7 mm.
i	1	0 : 1 : 1.5—2	0.9 mm.

The number of the rings of clawlets in the fourth and third instars varies in a certain extent. Of seven pairs of prolegs, the first pair has the rings most regular and scanty, namely, 9 or 9.5 in fourth stage, 6 or 6.5 in third stage; one or three rings are added usually to the third or fourth pair of prolegs. The rings are mostly complete, but the proximal one or two are often incomplete and semi- or quarter-circular.

Length of antennal segments varies rather remarkably in various stages. Proximal segment is thick and chitinised, and about as long as the ventral branch in fourth instar, but in the first and second instars it is practically absent. Dorsal branch is always much longer than the ventral.

Mr. Yie (1933), by measuring the body length of this species, has assumed that the larvae "may be grouped into 5 instars":

(i) 1.2—1.6 mm.; (ii) 2.1—2.7 mm.; (iii) 2.9—3.4 mm.; (iv) 3.7—4.3 mm.; (v) 4.6—5.3 mm.

This grouping of stages, however, seems to me to be incorrect because of the methodological inappropriateness.

Pulikovsky (1924) distinguishes three distinct groups of larvae in her specimens from Altai:

(i) Length of body, 1.5 mm.; row of claws, 5—6.
(ii) „ , 2.5 mm.; „ , 8—9.
(iii) „ , 4 mm.; „ , 10—13.

It seems to me that the first instar was lacking in the specimens at her disposal, and she has dealt only with the second to fourth instars.

K. Brodsky (1930) distinguishes four larval stages in his Central Asiatic specimens:

(i) Length of body, 0,98—1.3 mm.; rows of claws, 5—8.
(ii) „ , 1.8—2.5 mm.; „ , 10.
(iii) „ , 3—4 mm.; „ , 11.
(iv) „ , 4—5 mm.; „ , 13—14.

However, it seems to me that because of the disordery increase in size and number of claw rows, and of the variation of the latter in earlier stages, his scheme requires revision.

Fourth instar (full-grown) (numerous specimens) (figs. 23–26).

Body: plano-convex, consisting of twelve segments, of which the head and thoracic segments are distinct. Length about 4 mm.; breadth about 1.6 mm., but the size varies much seasonally. Mr. Yie recorded 5.3 mm. in his specimens from Kurama taken in January 1933, while I measured 3.2 mm. from my Kurokawado specimen in August 1937, which was already mature enough. Immature specimens just after moulting, are often less than 3 mm. Dorsal integument light orange with ill-defined irregular dark cinnamon markings and several light punctures; ventral side pale. Just before pupation, they become darker.

Head: free, distinct. Head capsule nearly flat, mainly dark brown, set with microscopical pubescences, posterior margin black and slightly extended under the prothorax. Antennae (fig. 25) bifurcated, each arising from a large tubercle with black borders. Proximal joint cylindrical, about four times as long as broad, well chitinised and dark brown; rather sparsely set with fine pale hairs on the dorsal inner margin. Distal joints unequal, pale, set with many microscopical prominences on their surfaces. Ventral branch cylindrical, nearly as long as the scapal joint, directed slightly ventrally. Dorsal branch more than twice or nearly thrice as long as the scape, tapering apically, and ends in a pointed tip. Eyes small, brownish. Clypeus projected forwards, dark brown

with black margins. Labrum massive, with a pair of longitudinal densely setaceous ridges. Mandibles each consisting of a basal chitin ring and a transverse brownish comb, which is furnished with many fine teeth directed towards the mouth. Maxillae: anterior margin densely setaceous and brown; palpus rounded, jointless, placed on chitinised prominence.

Thorax: segments distinct, with conically projected lateral margins. Dorsal integument set with a coarse transverse row of short setae and dense microscopical pubescences. Prothorax partly covers the posterior part of the head. Mesothorax larger than other segments. Just before pupation, pupal features such as the gill filaments on the lateral side of prothorax, wing-sacs on the sides of mesothorax and chitin bands on meso- and metathorax are visible under the skin.

Abdomen: consists of eight segments, of which the fourth is the broadest. Each segment except the last, bears a pair of unsegmented lateral outgrowths or prolegs, which are nearly as broad as the main portion of the segment, and are gradually curved ventro-laterally. Distal portion of each proleg (fig. 26) furnished with nine to twelve concentric rings of small blackish claws. Each claw consists of a long stalk and a comb-like plate with five sharp teeth directed outwards. Distal portion of each proleg is retractile, and serves as a kind of sucker after the claws are all drawn in. A pair of transverse rows of dense bundles of bristles are present on the anterior and posterior margins of each proleg. Each bundle consists of a short stalk and many slender hairs arranged in fan-like manner. Between the rows of brushy hairs is a intermediate row of very coarse, mostly simple bristles, of which laterally placed one or two are very long. The last segment (8.+9.+10.) much smaller than the others, and is posteriorly provided with a pair of slender appendages. They are strongly chitinised and curved postero-laterally, or stretched posteriorly, and sparsely set with short bristles or bundle of hairs. Dorsal integument of each segment, as well as the whole surface of caudal appendages, densely set with microscopical brownish pubescence. Ventral to the caudal appendages are five, white gill filaments, of which the anterior two paris are placed laterally and the remaining one is directed posteriorly; the foremost pair are larger than the others, nearly thrice longer than broad; the hind-most one is the smallest. Ventral integument pale, entirely glabrous, and the ganglia and ventral nerve cords are often visible under the skin.

Just before pupation, pupal features appear under the skin and the

abdomen becomes darker. Tergites of pupa each provided with transverse chitin bands as well as macro- and microgranulation; prolegs of first, second and seventh segments each with a pile of blakish spinelets.

Third instar (numerous specimens) (figs. 27, 28).

Length of body 1.5–3 mm., breadth 0.7–1.1 mm. Dorsal integument light yellowish, with irregular cinnamon markings; ventral nearly pale. Head capsule mainly dark brown, its posterior part blackish. Eyes brownish. Scapal joint of antennae nearly cylindrical, about twice as long as broad, its outer margin chitinised and dark brownish. Ventral branch of antennae cylindrical, two or two-and-half times as long as scapal joint; dorsal branch tapering apically, four or five times as long as scapal joint. Prothorax partly covers the posterior part of head. Rings of clawlets six in the first proleg, seven or eight in other prolegs. Clawlets of the next stage often observed under the skin in mature specimens. Brushy hairs of each proleg rather more sparse and shorter than in the fourth instar. Caudal appendages and anal gills normal.

Second instar (17 specimens) (figs. 29, 30).

Length of body 1.0–1.7 mm., breadth 0.3–0.6 mm. Dorsal integument pale, with irregular cinnamon markings; ventral side pale. Head capsule mainly dark brown. Eyes brownish. Scapal joint of antennae scarcely developed; dorsal branch two or two-and-half times as long as the ventral branch, pale. Prothorax rather indistinct, covering the posterior part of the head mostly. Rings of clawlets three in all prolegs. Clawlets of the next stage often observed under the thin cuticle in mature specimens. Brushy hairs of each proleg very short and sparse. A long bristle is found on the dorsal end of each proleg. Caudal appendages and anal gills normal.

REMARKS

The localities and other data of collection may be seen in the following table:

Date	Locality	Data	W. t.	Collector
20. IV. '26	Kurama (near Kyôto)	Pupa, Larva (iv)	11°C	Kitakami
25. IV. '26	Sakamoto (near Ôtu)	Pupa, Larva (iv)	12°	,,
15. VI. '26	Kurama (near Kyôto)	Pupa, Larva (iv)	14°	,,
11. VII. '26	,,	Pupa, Larva (iv)	18°	,,
31. X. '26	,,	Larva (iv)	12°	,,
16. IV. '27	Mt. Atago (near Kyôto)	Larva (iv)	9.5°	,,

23. IV. '27	Kibune (near Kyôto)	Larva (iv)	12°	,,
,,	Kurama (near Kyôto)	Pupa, Larva (iv, iii)	12°	,,
26. VI. '27	,,	Pupa	18°	,,
18. VII. '27	Iwanadome (Tokugo, Sinano)	Pupa	12°	,,
3. XI. '27	Ueda (Oze, Ettyû)	Pupa		,,
6. XI. '27	Maki (Sirakawa-go, Hida)	♀, Pupa		,,
23. IV. '29	Kurama (near Kyôto)	Pupa, Larva (iv, iii, ii)		,,
26. IV. '29	,,	Pupa, Larva (iv, iii, ii)		,,
27. IV. '29	Kibune (near Kyôto)	Larva (iii)		,,
,,	Seryô (near Kyôto)	Larva (iv, iii)		,,
11. V. '29	Kurama (near Kyôto)	Pupa, Larva (iv, iii)		,,
30. IV. '31	,,	Pupa, Larva (iv, iii, ii)		,,
7. V. '31	,,	Pupa, Larva (iv, iii, ii)		,,
14. V. '31	,,	Pupa, Larva (iv, iii)		,,
21. V. '31	,,	Pupa, Larva (iv, iii, ii)		,,
30. V. '31	,,	Pupa, Larva (iv)		,,
10. IX. '31	,,	Pupa, Larva (iv)		,,
26. III. '32	,,	Larva (iv, iii)		,,
1. V. '32	,,	Pupa		,,
30. VII. '32	Kurosawa (Kamikôti, Sinano)	Larva (iv)		,,
15. X. '33	Kurama (near Kyôto)	Pupa, Larva (iv, iii)		,,
28. IV. '34	,,	Pupa, Larva(iv, iii)		,,
15. V. '34	,,	Pupa, Larva (iv, iii, ii)		,,
19. V. '34	Mt. Hira (near Kyôto)	Pupa, Larva (iv)		,,
25. V. '34	Kurama (near Kyôto)	♀, Pupa, Larva (iv)		,,
27–28. V. '34	,,	♀, Pupa, Larva (iv, iii)		,,
8. VI. '34	Mt. Hira (near Kyôto)	♀, Pupa		,,
15. X. '34	Kurama (near Kyôto)	Pupa, Larva (iv, iii)		,,
11. XI. '34	,,	Pupa, Larva (iv, iii)		,,
20. IV. '35	,,	♀, Pupa, Larva (iv, iii, ii)		,,
14. V. '35	,,	♀, Pupa, Larva (iv)		,,
8. VI. '35	Mt. Hira (near Kyôto)	Pupa		,,
3. V. '36	Kurama (near Kyôto)	Larva (iv)		,,
14. VI. '36	Mt. Hira (near Kyôto)	♀, Pupa		,,
5. IV. '37	Tomoti (Higo, Kyûsyû)	Pupa (♂, ♀), Larva (iv)	9.5°	,,
20. VI. '37	Huruyado (Nagawa, Sinano)	Pupa, Larva (iv, iii)	14°	,,
,,	Kurokawado (,,)	Pupa (♂, ♀), Larva (iv,iii)	16.5°	,,
,,	Yakatahara (,,)	Pupa, Larva (iv)	13.6°	,,
21. VI. '37	Simasima (Sinano)	♀	9,6°	,,
1. VIII. '37	Kurokawado (Nagawa, Sinano)	Pupa (♂, ♀), Larva (iv)		,,
31. VIII. '37	,,	Pupa (♂, ♀)	17°	,,

The habitat of this species is restricted to the rapid mountain stream, where several members of Blepharoceridae are always found.

The altitude of our localities ranges from 150 m. to about 1,600 m. above the sea-level. The localities near Kyôto have remarkably low altitude, and form a striking contrast to those of other countries in which the altitude ranges from 1,000 m. to 3,800 m.

In its *life cycle*, this species is one of the members of the "perennial-type" introduced by me from one of our Blepharocerids, in which larvae and pupae are found throughout the year. This fact had also been well ascertained by Mr. Yie at Kurama. As for the problem of *generations*, it is difficult to make out their number, because different stages of metamorphosis co-exist throughout the year. But it may well be said with certainty, that the insect is apparently "poly-generative", as stated by Mr. Yie.

The scarcity of male individuals is quite striking. In most of the localities neither Yie nor I could ever find any male or male-pupa, in spite of that a large number of females as well as hundreds of female-pupae were secured. This fact seems to suggest us that this insect may reproduce by means of *parthenogenesis*, at least in the localities near Kyôto.

As to the *mode of living*, this species belongs to the "submersed-type" introduced by me from our Blepharocerids. The larvae and pupae are prevalent in very rapid though not necessarily bubbling streams. They are attached to the surface of smooth rocks or stones which are entirely submersed in the water. The attachment of the larvae is somewhat weak and they may be dislodged rather easily. The pupa adheres generally in a small hollow of the surface of stone by means of its six ventral pads.

From a mature pupa kept in the glass tube filled with water, a female imago emerged out, in the morning of 6, XI '27, at Sirakawa-go. At Kurama and Mt. Hira, I often observed the females caught by the spider's web hanging over the stream, and in the early morning of 28, V '34 some of them were seen still alive. In the early morning of 21, VI '37, at Simasima, I met with the swarm of this species and was able to catch with ease a large number of females on wing by a collecting net. Their flight was rather slow. From these facts, the assumption may be possible that the emergence takes place in the mid-night or at dawn.

DEUTEROPHLEBIA TYOSENENSIS SP. NOV.

PUPA (7 specimens) (figs. 31, 32)

Male-pupa (4 specimens of which 2 are exuviae), measuring 2.0×

1.4 mm.—2.2 × 1.5 mm.; *female-pupa* (3 specimens), measuring 1.8 × 1.3 mm.—2.0 × 1.5 mm.

General features similar to those of the above-mentioned species, except for the following differences:

1) Lateral projections of the first abdominal segment are slightly more eminent.

2) The microgranulation of the dorsal integument is normal, but the chitin bands and the macrogranulation are absent from the abdominal segments. Mesothorax and metathorax each with a pair of transverse bands only, and in one female-pupa those on the metathorax are very much reduced. Abdominal segments each with a few granules of moderate size instead of chitin bands, except in one female-pupa where the bands are preserved.

3) Respiratory horns are normal, but the distal portions of the filament are silvery white.

4) On the dorsal side of each respiratory horn occur a pair of very long blackish thorns, which arise from the chitinised prominences, arranged before and behind, directed laterally and slightly forwards. They are nearly similar in size and length, and fairly longer than the chitin band of the mesothorax; basal part slightly thicker than the gill filaments, but tapering apically in a sharply pointed tip.

5) Spinelets are normal, but those of the first and second abdominal segments are rather longer and more scanty.

LARVA

Fourth instar (2 specimens of which one is full-grown).

Full-grown larva measures 3.6 × 1.3 mm. General features nearly similar to those of the above-mentioned species, except for the differences as follows:

1) Dorsal integument dark brownish, with irregular light markings.

2) Antennae: Scapal joint fairly narrowed and strongly chitinised towards the tip, less than four times as long as broad; ventral branch slightly shorter than the scape; dorsal branch less than twice as long as the scape.

3) On both sides of the labrum in the full-grown specimen, a pair of T-shaped processes are found, which are projected forwards and set with short dense setae on the apical portions.

4) Mesothorax much larger than the rest of the thoracic segments.

5) Rings of clawlets of the prolegs are nine to eleven.

6) Caudal appendages nearly straight, directed backwards.

Third instar (5 specimens).

A specimen just before moulting, measures 1.8×0.7 mm.; immature ones 1.3–1.4 mm. in length. Dorsal integument obscurely dark brownish. Scapal joint of antennae about one-and-half times as long as broad, its outer margin chitinised fairly well. Ventral branch nearly twice as long as the scape; dorsal branch four or five times as long as the scape. Rings of clawlets 6–8. In a mature specimen, clawlets of the next stage under the skin number 11–13.

First instar (a single specimen) (fig. 33).

Body slender, measuring about 0.9 mm. in length; light brownish or nearly pale and glabrous throughout. Head capsule fairly well chitinised and dark. Antennae with no scapal joint, and the branches arising directly from a large tubercle. Ventral branch cylindrical, three or four times as long as broad; dorsal branch tapering apically, nearly twice as long as the ventral branch; each set with a large number of microscopical prominences on the whole of the surface. Prothorax rather indistinct. Abdominal prolegs resemble the retractile hooked-appendages of the first instar of the submersed type of Blepharoceridae. Ring of clawlets apparently single, the clawlets normal, blackish brown. Pale clawlets of the next stage already visible under the skin, but too immature to be counted. Brushy hairs are absent, but a single bundle of several short setae as well as a short simple hair are found on the dorsal side of each proleg. Anal gills rather large. Caudal appendages not eminent.

Localities and the data of collection:

Date	Locality	Data	Collector
27. VIII. '29	Myokissyo (Mt. Kongô, Tyôsen)	Pupa, Larva (iv, iii)	Kitakami
„	Mt. Birô-hô („)	Pupa, Larva (iv)	„
12. VI. '36	Reika (Kankyônandô, Tyôsen)	Larva (i)	Kawamura

The life cycle and habits are probably similar to those in the above-mentioned species. It is somewhat dubious whether the Reika specimen belongs to this species, though it is likely because of the geographical reason. The specimens of Mt. Kongô are associated with a Blepharocerid, *Philorus chosenensis* Kitakami (1931), as well as a Simuliid. The unique specimen from Reika is associated with two Blepharocerids, *Bibiocephala infuscata* Matsumura (1916) and *B. montana* Kitakami (1931).

DISCUSSION ON THE CLASSIFICATION OF THE SPECIES

The identification of the species of *Deuterophlebia* must be undertaken primarily on the male, because the unique species, *D. mirabilis* Edwards (1922) was described on the male. The male of the Japanese form of *Deuterophlebia* dissected from mature pupae shows remarkable resemblance to *D. mirabilis*, but it has not a few important differences in the characteristics of the antennae, legs and others, as shown in the following table:

D. mirabilis Edw.	*D. nipponica* sp. nov.
The last segment of antennae "practically bare": "Terminal joint bare except for a few fine hairs near the base."	—— more or less *densely* set with slender fine hairs on the whole inner side of the segment.
First flagellar segment with "one or two short bristles . . . . "	—— with about ten short bristles.
2. and 3. flagellar segments each with "a very few short and fine hairs on the dorsal surface."	—— without hairs on the dorsal surface.
Legs "absolutely bare except for a fine, close, erect pubescence on the outer two thirds of the tibiae."	*Femora* sparsely set with short bristles. Tibiae and *tarsi* densely set with fine, erect, apically knobbed hairs mainly on the flexor surface.
Wings with "a rather long and delicate fringe round the anal lobe."	—— with a long and delicate fringe on the most of the posterior margin.
Lateral margins of abdominal segments with "groups of two or three minute bristles."	6. and 7. segments each laterally with a small tubercle with five or six short bristles; their tergites each with a coarse, transverse row of short bristles.

The structure of the male hypopygium of *D. nipponica* sp. nov. nearly agrees to the original description of Edwards, in which the dorsal aspect is not figured. But Brodsky's figure of *D. mirabilis* from Central Asia shows obviously an unneglectable difference in the form of the tenth tergite.

Taking in account the geographical separation of the localities of these two forms, Kashmir and Japan, in addition to the morphological differences above mentioned, the Japanese form seems to have a sufficient specific rank different from *D. mirabilis* Edwards.

The female of *D. nipponica* sp. nov. differs from the Central Asiatic *D. mirabilis* identified by Brodsky, in the possession of (1) short bristles as well as a dense pubescence on the femora, tibiae and tarsi,

(2) and of a coarse transverse row of short bristles on the dorsal side of the 6th and 7th abdominal segments. The female hypopygium of these two species are also slightly different. Pulikovsky's description of the female from the Altai Mountains is too general to show the specific characteristics; but it is obvious that it is different from that of the Japanese species, because the pupa from which it was dissected is quite different.

The pupa of *D. nipponica* sp. nov. differs from most of the Altai specimens described and figured by Pulikovsky in lacking the long sharp thorns on the dorsal side of mesothorax. It is also different from Brodsky's *D. mirabilis* from Central Asia in possessing the transverse chitin bands and a macrogranulation on the tergite, though these two species are the same in lacking the sharp thorns.

The pupa of *D. tyosenensis* sp. nov. differs from those of *D. nipponica* sp. nov. and Brodsky's *D. mirabilis* from Central Asia in having the long sharp thorns on the dorsal side of mesothorax. It differs also from Pulikovsky's Altai specimens in the possession of two pairs of long thorns, while the latter has only one pair of thorns.

The larvae of *D. nipponica* sp. nov. are different from those of Brodsky's *D. mirabilis* as well as Pulikovsky's Altai specimens mainly in having smaller number of rings of clawlets on the proleg. The larvae of *D. tyosenensis* sp, nov. differs from the Japanese species mainly by the darkness of the dorsal integument.

If Muttkowski's Yellow-Stone specimens are different from the others, we have now five species in the family Deuterophlebiidae.

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EXPLANATION OF PLATES 25–27

Plate 25

Deuterophlebia nipponica sp. nov.

Fig. 1. Head of male, dissected from pupa (last flagellar joint mostly omitted) ;
a) Middle portion of last flagellar joint ;
b) Distal portion of last flagellar joint ; frontal view, × 54.
2. Head of male, dissected from pupa (last three flagellar joints omitted) ; seen from beneath, × 54.
3. Fore-leg of male, dissected from pupa ; ventral view, × 54.
4. Mid-leg of male, ,, ; ,, , × 54.
5. Hind-leg of male, ,, ; ,, , × 54.
6. Last tarsal joint of mid-leg of male, dissected from pupa, × 200.
7. Male hypopygium, dissected from pupa ; dorsal view, × 54.
8. ,, ; ventral view, × 54.
9. Head of female, dorsal view, × 54.
10. ,, , ventral view, × 54.
11. Flagellum of female, × 200.

Plate 26

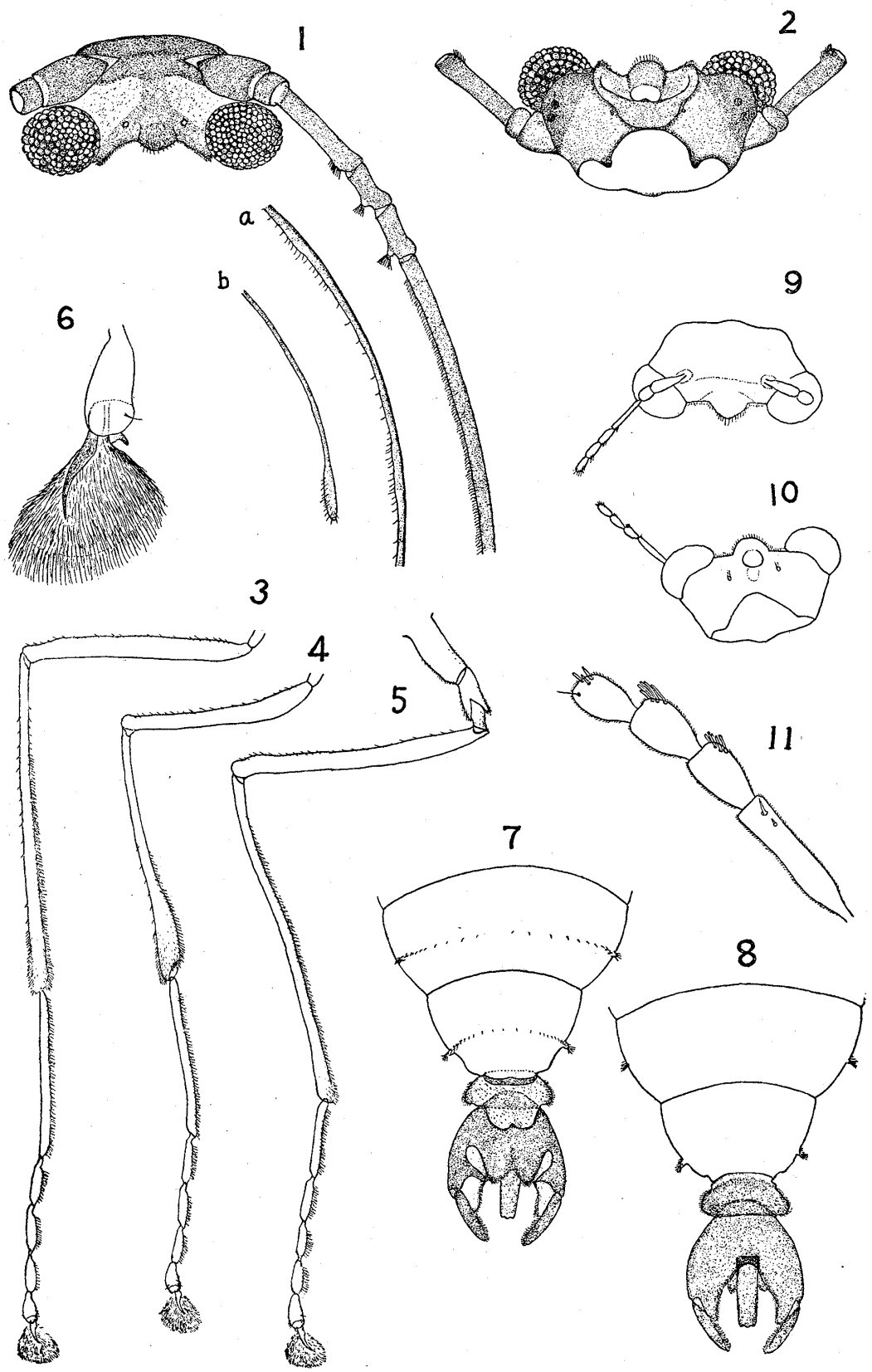
Fig. 12. Wing of female, × 20.
13. Fore-leg of female, × 40.
14. Mid-leg of female, × 40.
15. Hind-leg of female, × 40.
16. Distal portion of last tarsal joint of female fore-leg, × 150.
17. Female hypopygium ; dorsal view, × 40.
18. ,, ; ventral view, × 40.
19. Male-pupa (microgranulation omitted) ; dorsal view, × 20.
20. ,, ; ventral view, × 20.
21. Female-pupa (microgranulation omitted) ; dorsal view, × 14.
22. ,, ; ventral view, × 14.

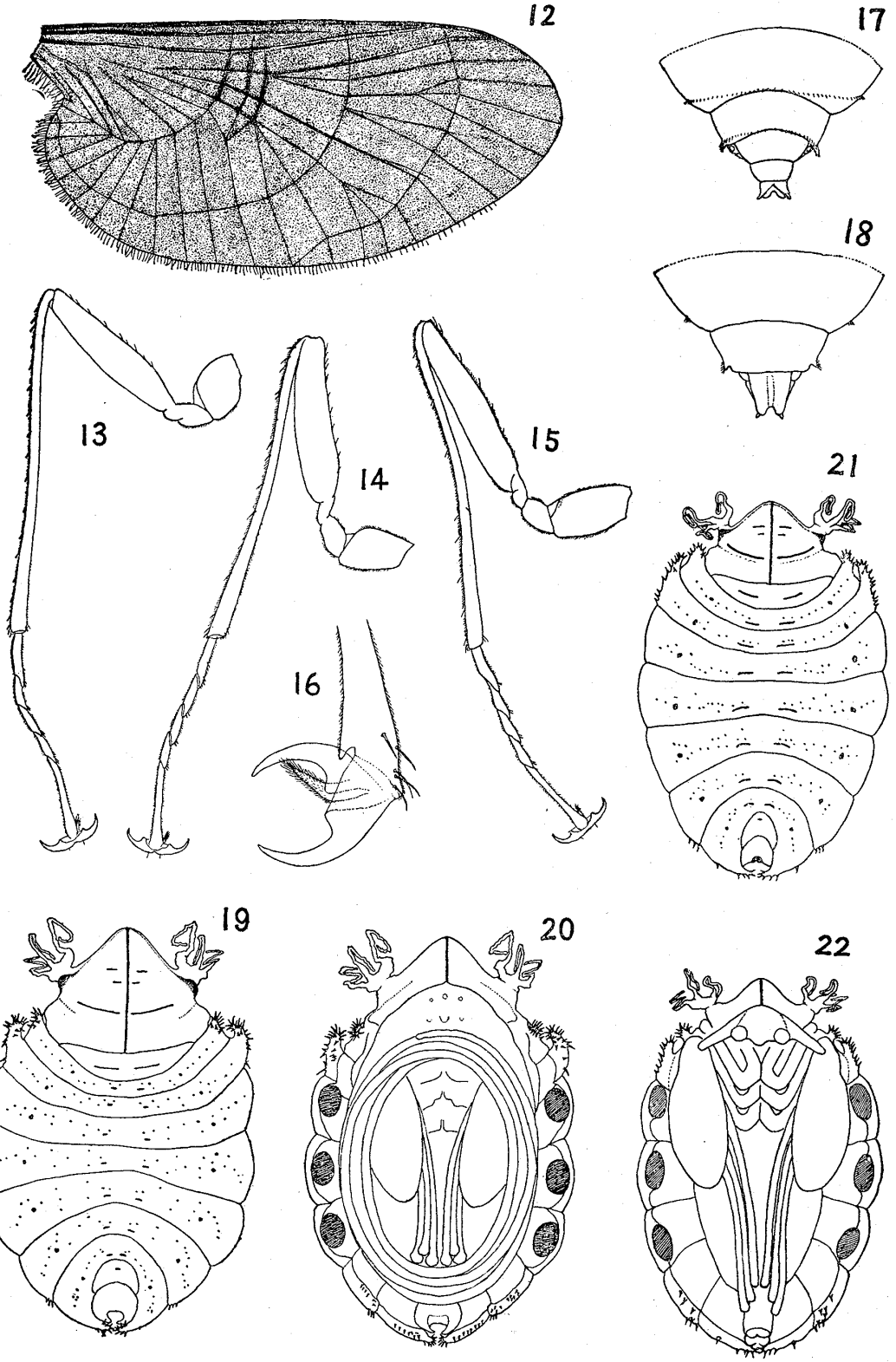
Plate 27

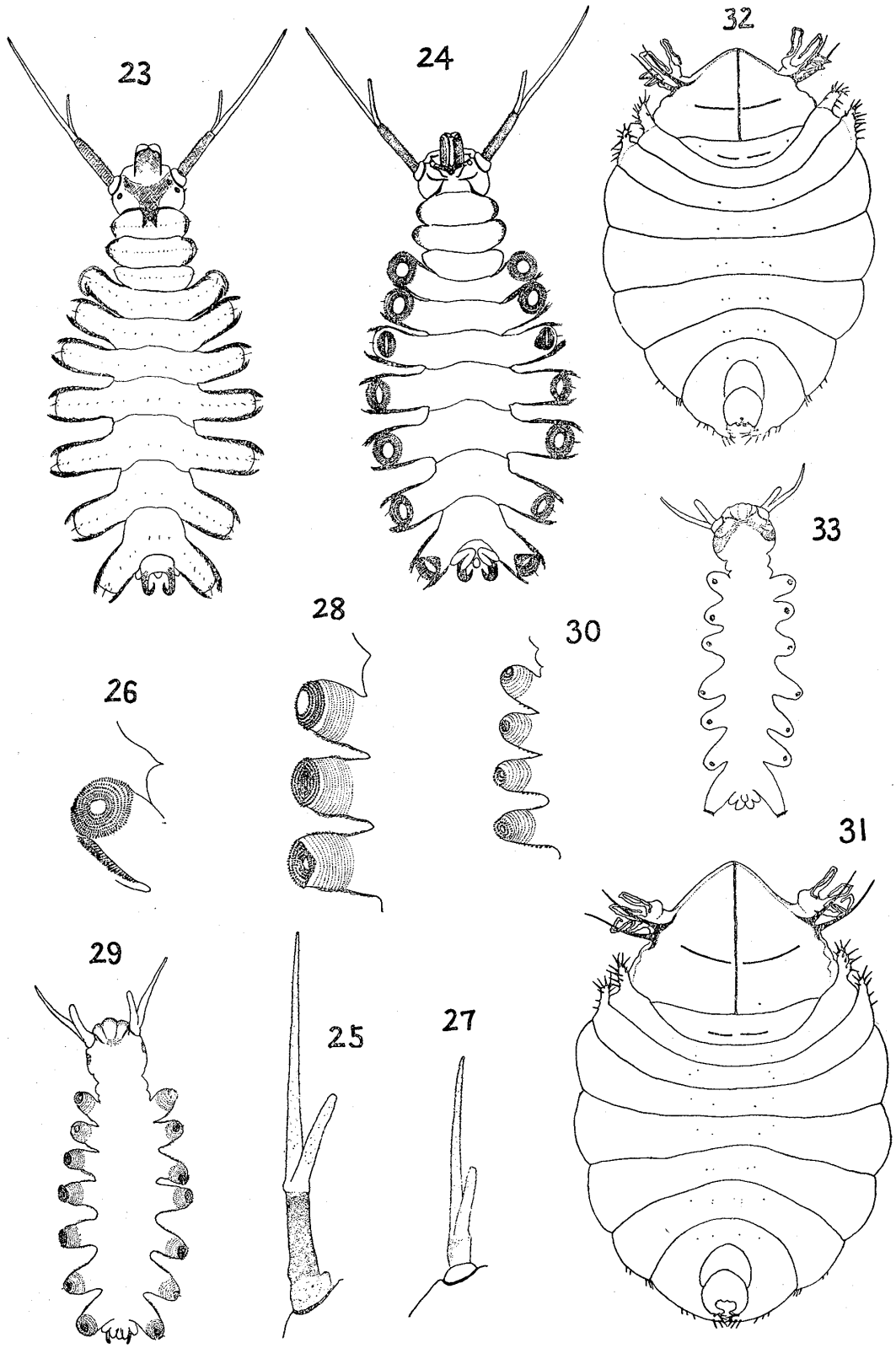
Fig. 23. Larva, fourth instar (full-grown); doral view, × 14.
24. „ ; ventral view, × 14.
25. Antenna of fourth instar; ventral view, × 40.
26. First proleg of fourth instar (full-grown); ventral view, × 40.
27. Antenna of third instar; ventral view, × 40.
28. First three prolegs of third instar (just before moulting); ventral view, × 40.
29. Second instar (just before moulting); ventral view, × 25.
30. First four prolegs of second instar; ventral view, × 40.

Deuterophlebia tyosenensis sp. nov.

Fig. 31. Male-pupa (microgranulation omitted); dorsal view, × 25.
32. Female-pupa („); dorsal view, × 25.
33. First instar; ventral view, × 40.







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