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Morphological and Geographical Notes on the Genus *Palaeagapetus* in the Asian Far East, with Descriptions of Two New Species (Trichoptera, Hydroptilidae)

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Abstract Variations of males of *Palaeagapetus ovatus* ITO et HATTORI and *P. parvus* ITO are reported. Two new species, *P. kyushuensis* ITO et KUHARA and *P. shikokuensis* UTSUNOMIYA et ITO, are described from southern Japan. Geographical distribution of the Asian Far Eastern species of this genus is summarized.

Key words: Trichoptera; *Palaeagapetus*; new species; variation; the Asian Far East.

Palaeagapetus ULMER is a small genus with seven species distributed in the Holarctic region; i.e., a fossil species from Baltic Amber (ULMER, 1912), two extant species in the Nearctic (BANKS, 1936; ROSS, 1938) and four extant species in the Asian Far East (ITO and HATTORI, 1986; BOTOSANEANU and LEVANIDOVA, 1987; ITO, 1991a, b). This paper adds the eighth and ninth species from southern Japan. Variations of males of *P. ovatus* ITO et HATTORI and *P. parvus* ITO also are reported, and geographical distribution of the Asian Far Eastern species is summarized.

Filiation of adults and larvae is established by rearing larvae to adults and by dissecting mature pupae to examine their genitalic segments. Identification is based on the males by the first author unless otherwise indicated. Morphological terms used in this paper are referred to BOTOSANEANU and LEVANIDOVA (1987) and figures are based on the specimens of type localities unless otherwise indicated. Type specimens are deposited in the collection of the Natural History Museum and Institute, Chiba (CBM-ZI), and other specimens are deposited in the collections of the first author (without indication), N.

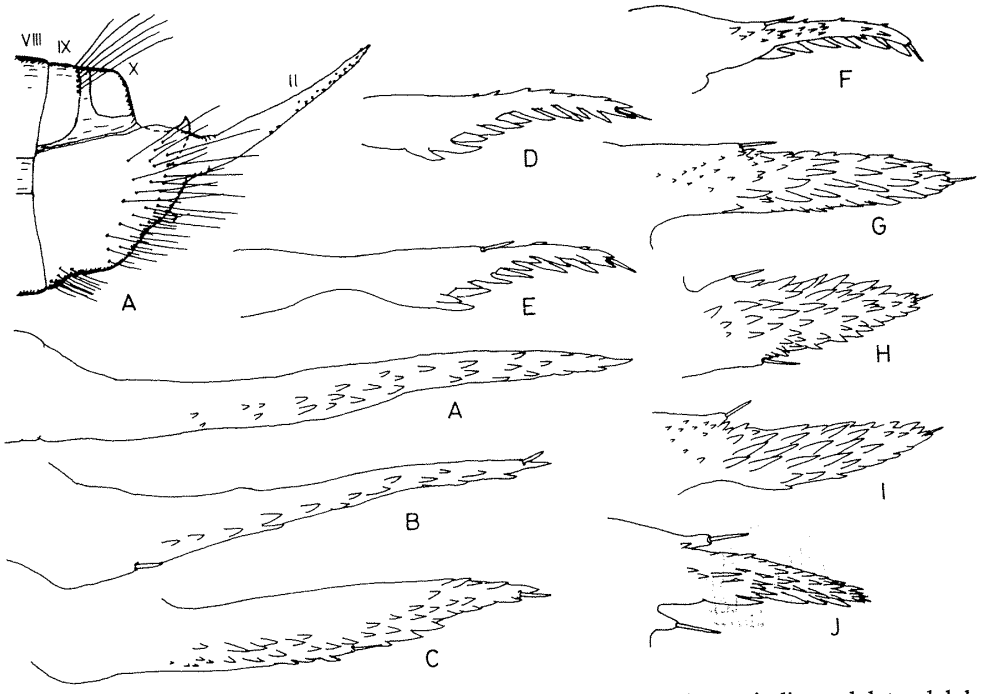

Fig. 1. Variations of male genitalia of *Palaeagapetus ovatus*. A, genitalia and lateral lobe of inferior appendage of male from Chitose, Hokkaido (type locality), lateral view. B–J, lateral lobe of inferior appendage, lateral view: B, Hakodate; C, Akita; D, Tochio, Niigata; E, Yunotani, Niigata; F, Fukushima; G, Tochigi; H, Ichinose, Yamanashi; I, Ôhikage, Yamanashi; J, Gifu. Abbreviations: VIII–X, segments VIII–X; ll, lateral lobe of inferior appendage.

KUHARA (NK) and Institute of Biology and Pedology, Vladivostok (IBP).

Palaeagapetus ovatus ITO et HATTORI

(Fig. 1)

Palaeagapetus ovatus ITO et HATTORI, 1986, 143–151, ♂, ♀, pupa, larva, egg, case of larva, bionomics; ITO, 1988, 148-154, life cycle.

Variation of male. Lateral lobe of inferior appendage is variable geographically. The lobe is slender and with a very few spines on the lateral side in the males of Chitose, Hokkaido (type locality) (Fig. 1A) and eight other localities of Hokkaido listed in below. In comparison with males from Chitose, lateral lobe is a little shorter in males from Hakodate (Fig. 1B) and Kikonai. In comparison with males from Hakodate, lateral lobe is shorter and more spinous in the males from Akita (Fig. 1C). In males from Tochio, Niigata (Fig. 1D), Yunotani, Niigata (Fig. 1E) and Fukushima (Fig. 1F), the lobes are further shortened and very spinous; the spines are present on ventral surface rather than the lateral, since the lobe more or less kinked near the base in the males of

the three localities. The lobes of males from Tochigi (Fig. 1G), Ichinose, Yamanashi (Fig. 1H), Ôhikage, Yamanashi (Fig. 1I) and Gifu (Fig. 1J) are short, thick and spinous. In general, lateral lobe is shortened and more spinous from northern localities to the south.

Specimens examined. [Hokkaido] 1♂, Mt. Soranuma, Sapporo, 5. VII. 1989, N. KUHARA (NK). 4♂, do., 27. VI. 1990, NK. 1♂, a brooklet near Nakayama-toge, Sapporo, 28. VI. 1992, NK. 3♂, Kannon-zawa, Misumai, Sapporo, 16. VII. 1992, NK. 2♂1♀, Rankoshi, Chitose, 4. VI. 1992, T. ITO (TI). 4♂4♀, Eniwa Park, Eniwa, IV.1992, TI. 25♂10♀, do., IV-IX. 1996, TI. 1♂6♀, a brooklet of Izari River, 510 m, Eniwa, 3.IV.1990 (larvae), reared and emerged in VI.1990, TI. 1♂, source of Horonai Creek, Takaoka, Tomakomai, 3. VII. 1989, TI. 1♂, source of Yuburi River, 7. IX. 1990, NK. 2♂, a spring, Kyogoku-cho, 10. IV. 1992 (larvae), reared and emerged in VI. 1992, TI. 1♂, Inaho-toge, 270 m, Kucchan-cho, 3. IV. 1992 (larva), K. KURIBAYASHI, reared and emerged on 2. VII. 1992, TI. 18♂, Kikyo, Hakodate, 17. I. 1988 (larvae) reared and emerged on 9-27.III.1988, TI. 1♂, Izumisawa, Kikonai-cho, 21. V. 1988 (larva), reared and emerged on 2. VII. 1988, TI. [Akita] 10♂ 9 5th instar larvae, Shikuma-zawa, Kosaka-machi, 30. VIII. 1987, TI. [Niigata] 1♂, Nishi-nakanomata, Tochio, 4. VI. 1993, NK. 8♂, a brooklet beside Sanashi River, 300 m, Yunotani-mura, 4. VI. 1993, NK. [Fukushima] 1♂, Mizunashi River, 800 m, Tajima-machi, 26. VIII. 1994, T. HATTORI. [Tochigi] 21♂12♀, spring, Chugu, Nikko, 10. IV. 1987 (pupae), emerged in V. 1987, TI. [Yamanashi] 3♂6♀, a brooklet, 1280 m, Shogen-toge-shita, Ichinose, Enzan, 13. II. 1992, S. UCHIDA and TI (larvae), reared and emerged in V. 1992, TI. 4 ♂, do., 22. III. 1993 (larvae), reared and emerged in V.1993, T. NOZAKI, T. KAGAYA, H. KUSANO and TI. 1♂1♀, Ôhikage-zawa, 1580 m, Yanagisawa Creek, Enzan, 12. II. 1992 (larvae), T. NOZAKI, T. KAGAYA and TI, reared and emerged in IV. 1992, TI. 2♂, do., 22.III.1993 (larvae), T. NOZAKI, T. KAGAYA and TI, reared and emerged in V. 1993, TI. [Gifu] 1♂, Takidani-deai, 1770 m, Gamada River, Kamitakara-mura, 26. VII. 1992, T. HATTORI.

Distribution. Hokkaido (Ishikari, Iburi, Oshima), Honshu (Akita, Fukushima, Niigata, Tochigi, Yamanashi, Gifu).

Palaeagapetus parvus ITO

(Fig. 2)

Palaeagapetus parvus ITO, 1991a, 359–365, ♂, ♀, pupa, larva, egg, case of larva, bionomics.

Variation of male. Inferior appendage consisted of thick lateral and thin ventral lobes. In the males from type locality (Mt. Hyonosen, Hyogo) and many localities except Wakayama (shown with an arrow in Fig. 5) listed below,

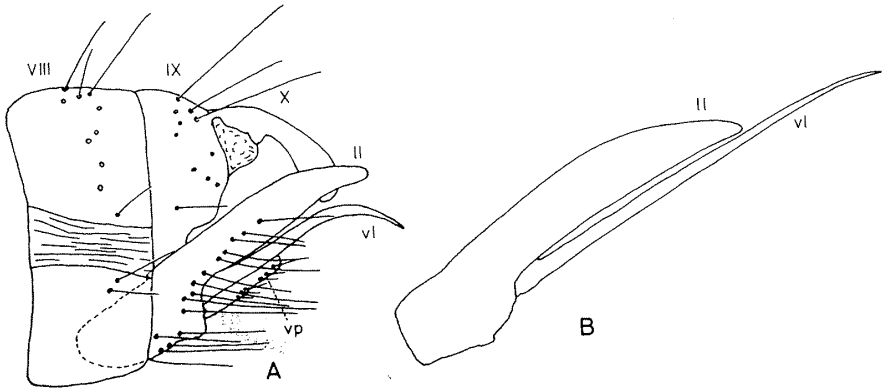

Fig. 2. Variation of male genitalia of *Palaeagapetus parvus*. A, genitalia and lateral lobe of inferior appendage of male of Mt. Hyonosen, Hyogo (type locality), lateral view, aedeagus is omitted; B, inferior appendage of a male from Wakayama, lateral view, setae are omitted. Abbreviations: vl, ventral lobe of inferior appendage; vp, ventral plate; others as in Fig. 1.

ventral lobe directed dorso-caudally at basal 2/3 and curved ventrally at apical 1/3; ratio of length of ventral lobe to length of lateral lobe about 1 : 1 (Fig. 2 A). On the other hand, ventral lobe very long, the ratio almost 1.5 : 1 and scarcely curved at apex in a male from Wakayama (Fig. 2B).

Specimens examined. [Hyogo] 18♂4♀, a brook near Shindai-goya, 1350 m, Mt. Hyonosen (type locality), 4. XI. 1988 (larvae), NK, reared and emerged in IV. 1989, TI. [Niigata] 6♂, a brooklet beside Sanashi River, 300 m, Yunotani-mura, 4. VI. 1993, NK. [Yamanashi] 1♂, Ôhikage-zawa, 1580 m, Yanagisawa River, Enzan, 6.VI.1991, T. NOZAKI. 3♂1♀, do., 12.II.1992 (larvae), T. NOZAKI, T. KAGAYA and TI, reared and emerged in IV. 1992, TI. 1♂1♀, do., 22. III. 1993 (larvae), T. NOZAKI, T. KAGAYA and TI, reared and emerged in V. 1993, TI. [Shizuoka] 1♂, Yokokubo-sawa, 1600 m, Akaishi Mts., 20.VI.1990, T. HATTORI. 1♂, Ôishizawa, 650–800 m, Tashiro, Shizuoka, 13. V. 1990, T. HATTORI. [Wakayama] 1♂1♀, Takinohai, Koza-cho, 30. X. 1991, K. OKAZAKI, Y. NAGAYASU, K. SAITO and TI (larvae), reared and emerged in V. 1992, TI. [Ishikawa] 5♂5♀, Toyonomizu, 220 m, Nanao-joshi, 10. IV. 1988 (larvae), reared until after next generation and emerged in III. 1990, TI. [Nara] 1♂1♀, a brooklet near Furusato-no-mura, 380 m, Mameo, Higashi-yoshino-mura, 2. XI. 1991 (larvae), reared and emerged in IV. 1992, TI. [Kyoto] 1♂2♀, Ashu, Miyama-cho, 27. IV. 1993, NK. [Tottori] 2♂1♀, a brooklet beside Hasari Creek, Wakasa-cho, 26. V. 1993, NK.

Distribution. Honshu (Niigata, Yamanashi, Shizuoka, Wakayama, Ishikawa, Nara, Kyoto, Hyogo, Tottori).

Palaeagapetus flexus ITO

Palaeagapetus flexus ITO, 1991b, 419–426, ♂, ♀, pupa, larva, egg, case of larva, life cycle,

bionomics.

Variation. Have not been found.

Specimens examined. [Hokkaido] 1♂, Higashino-dottomari Creek, Rishiri-cho, 11. VII. 1995, Malaise trap, M. SATÔ 3♂2♀, do., 11–23. VII. 1995, M. SATÔ determined and deposited by NK. 10♂, a seeping spring near Yambetsu Creek, Shikaoi-cho, 29. V. 1988 (larvae), reared and emerged in VII. 1988, TI. 1♂2♀, Kikanko Creek, Obihiro, 27–30. VI. 1995, Malaise trap, A. OHKAWA. 1♂, a brooklet, Nissho-toge, Shimizu-cho, 12. VII. 1992, NK. 6♂, Mt. Yubari, 650-1400 m, Yubari, 4–5. VII. 1991, NK. 1♂, Mt. Yubari, 650 m, Yubari, 4. VII. 1993, TI. 1♂, Osatsunai, Urausu-cho, 17. V. 1992 (larva), K. KURIBAYASHI, reared and emerged in VII. 1992, TI. 7♂, Eniwa Park, Eniwa, 8–19. VII. 1996, TI. 1♂1♀, a western source of Bibi River, Bibi, Chitose, 3. VII. 1989, TI. [Iturup] 1♂, Dobroye Nachalo Bay, near waterfall, 14. VIII. 1994, V. A. TESLENKO, identified by T. J. AREFINA and deposited in IBP. [Sakhalin]: identified by T. S. VSHIVKOVA and deposited in IBP. 1♂1♀, Blagodatny Creek, Ado-Tymovo Village near Fish Hatchery, Tym River Basin, 10.VII.1985, E. A. MAKARCHENKO. 1♂, spring near Mt. Chekhova, Korsakovsky Region, 29. VI. 1973, ZHILTZOVA. 1♀, a tributary of Belaya River (upper part), Dolinskyi Region, 25.VII.1986, E. A. MAKARCHENKO.

Distribution. Hokkaido (Soya, Nemuro, Tokachi, Sorachi, Hidaka, Ishikari, Iburi), Iturup, Sakhalin (north, south).

Palaeagapetus kyushuensis ITO et KUHARA, sp. nov.

(Fig. 3)

Male. Body black and 2.7–3.3 mm long.

Genitalia (Fig. 3A–G). Tergite X thin at basal 1/3 and broad at apical 2/3 in dorsal view (Fig. 3E). Two pairs of small sensillae present on caudal margin (Fig. 3F); the sensillae with a few spines. Aedeagus thick and membranous (Fig. 3A). Inferior appendage (Fig. 3A–D) flattened laterally and consisted of lateral and ventral lobes; both lobes similar in thickness in lateral view. Lateral lobe long with round apex, about 1.5 times as long as tergite X (Fig. 3A). Ventral lobe very long, ratio of ventral lobe to lateral lobe about 1.9 : 1; a long fork present near base of ventral lobe (Fig. 3A–C). Shape of ventral lobe and fork variable individually and even at opposite side of a specimen; apical margin, and also dorsal and ventral margins in some specimens, comblike (Fig. 3A, B), but sometimes a shallow concave alone (Fig. 3D); the fork with a deep fissure at tip in some specimens (Fig. 3B, C). Ventral plate (Fig. 3G) setose with straight lateral margins and concave caudal margin with a small middle concave.

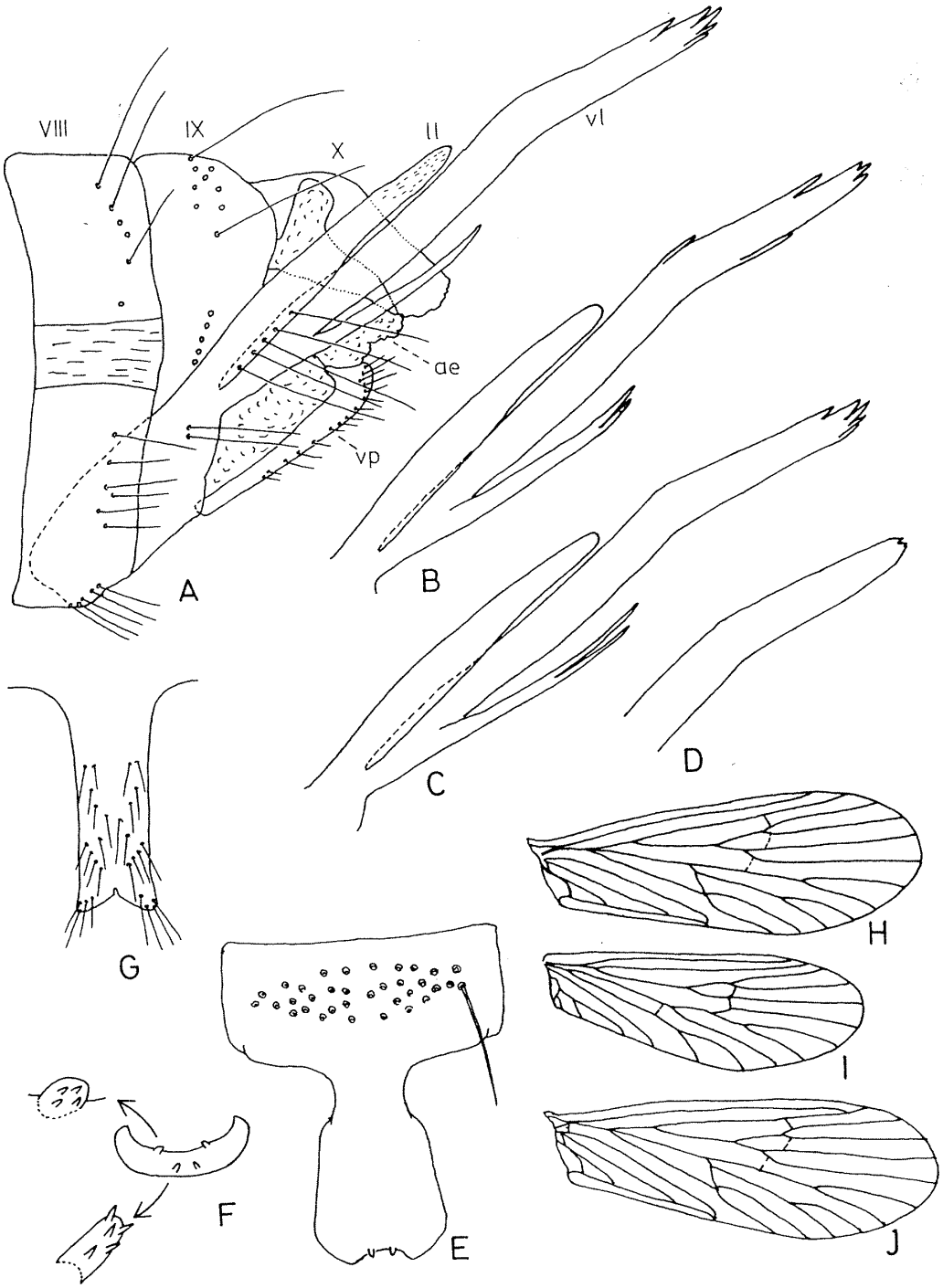

Fig. 3. Male of *Palaeagapetus kyushuensis* ITO et KUHARA, sp. nov. A–G, genitalic segments; A, lateral view; B–D, variations of inferior appendages, lateral view; E-F, Xth segment; E, dorsal view; F, top of the segment, caudal view; G, ventral plate, ventral view. H, fore wing. I, hind wing. J, variation of fore wing venation. Abbreviations: ae, aedeagus; others as in Figs. 1, 2.

Other features including wing venations(Fig. 3H–J) are very similar to those of *P. parvus* (ITO, 1991a).

Female, pupa, larva and larval case. Very similar to *P. parvus*, and indistinguishable from the latter in the present study. Body length: female 3.5–3.9 mm; male pupa 4.2–4.5 mm; female pupa 4.3–4.9 mm; full grown larva 4.5 mm at maximum. Case of larva 6.5 mm long and 2.0 mm wide at maximum.

Egg. Sphere or oval, pale yellow and about 0.39 mm×0.43 mm in size.

Holotype. ♂, a brooklet in Hikosan Biological Station of Kyushu University, Hikosan, Soeda-cho, Fukuoka, 19. V. 1993, NK (CBM-ZI-33947).

Paratypes. 8♂1♀, same data as holotype (CBM-ZI-33948～33956).

Other specimens. [Fukuoka] Type locality: 4 5th instar larvae, 3–4. XI. 1993, T. NOZAKI; 4♂1♀, 3–4. XI. 1993, T. NOZAKI (larvae), reared and emerged in V-VI. 1994, TI; 29 5th instar larvae and 4 prepupae, 3–4. XI. 1993, T. NOZAKI (larvae), reared and preserved in III. 1995, TI; 35 pupae (16♂19♀), 3–4. XI. 1993, T. NOZAKI (larvae), reared and preserved on 27.IV.1995, TI; 14♂14♀, 3–4. XI. 1993, T. NOZAKI (larvae), reared through a generation and emerged in V-VI. 1995, TI. A brooklet in Takasumi-jinja, Hikosan, Soeda-cho: 3♂9♀, 4.XI.1993, T. NOZAKI (larvae), reared and emerged in V–VI. 1994, TI; 25♂17♀, 3 pupae (1♂2♀), 4.XI.1993, T. NOZAKI (larvae), reared through a generation and emerged (or preserved) in V–VI. 1995, TI; 78♂38♀, 4. XI. 1993, T. NOZAKI (larvae), reared through 2 generations and emerged in V–VI. 1996, TI; 1 5th instar larva, 12. X. 1994, NOZAKI. [Kumamoto] 1♂1♀, Momiki, Izumi-mura, 21. V. 1993, NK. 1♂, Hayakusu, Tomochi-machi, 21. V. 1993, NK.

Distribution. Kyushu (Fukuoka, Kumamoto).

Etymology. Referring to the type locality.

Remarks. This species is similar to *P. parvus*, but distinguishable from the latter in shape of inferior appendage of male genitalia: ventral lobe slender and without any comb-like structures at apex in *P. parvus*; ventral lobe thick, comb-like at apex and with a long fork in *P. kyushuensis.* Female, pupa, larva and egg are indistinguishable from *P. parvus.*

Palaeagapetus shikokuensis UTSUNOMIYA et ITO, sp. nov.

(Fig. 4)

Male. Body black and 2.9–3.4 mm long.

Genitalia (Fig. 4A–D). Tergite X thin at basal 1/3 and broad at apical 2/3 in dorsal view (Fig. 4C). Two pairs of small sensillae present on caudal margin (Fig. 4C); the sensillae with a few spines. Aedeagus thick and membranous (Fig. 4A). Inferior appendage (Fig. 4A, B) flattened laterally and consisted of lateral and ventral lobes; both lobes similar in thickness in lateral view (Fig. 4 A). Lateral lobe long with round apex, 1.5 times as long as tergite X. Ventral lobe very long, ratio of ventral lobe to lateral lobe about 1.9 : 1; comb-like at

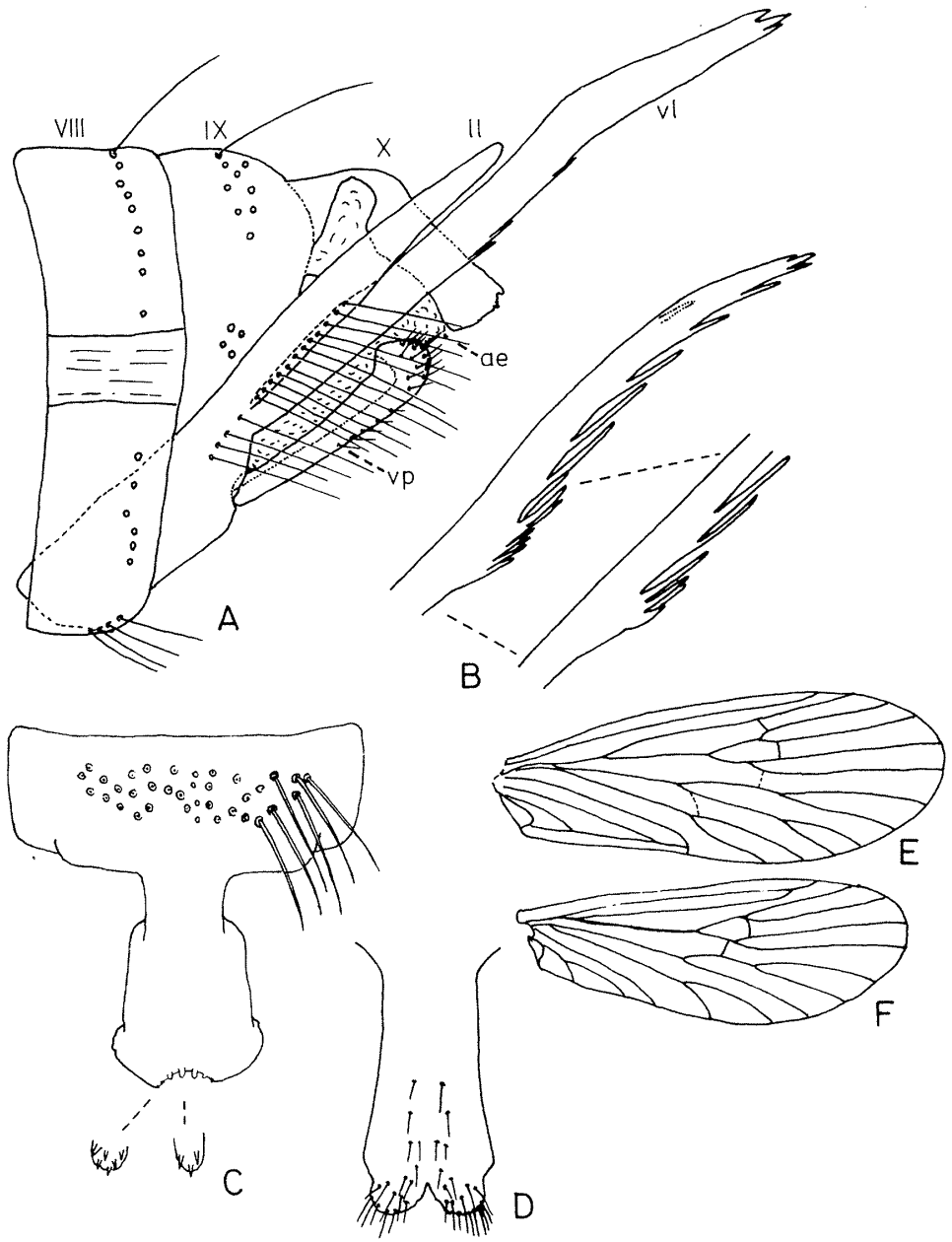

Fig. 4. Male of *Palaeagapetus shikokuensis* UTSUNOMIYA et ITO, sp. nov. A–D, genitalic segments; A, lateral view; B, inferior appendage, ventro-lateral view; C, Xth segment, dorsal view; D, ventral plate, ventral view. E, fore wing. F, hind wing. Abbreviations as in Figs. 1–3.

apical half of ventro-lateral margin (Fig. 4B); fork absent on ventral margin. Ventral plate (Fig. 4D) setose with round apical margin with a middle large concave.

Other features including wing venation (Fig. 4E, F) very similar to those of *P. parvus* (ITO, 1991a) and *P. kyushuensis*.

Female, pupa, larva and larval case. Very similar to *P. parvus* and *P. kyushuensis* and indistinguishable from the latters in the present study. Body length: female 3.1–4.3 mm; male pupa 4.2–4.5 mm; female pupa 4.3–4.8 mm; full grown larva 4.3 mm at maximum. Case of larva 4.8 mm long and 1.5 mm wide.

Holotype. ♂, Sagawa, Shigenobu-cho, Ehime, 28. IV. 1989, Y. UTSUNOMIYA (YU) (CBM-ZI-33957).

Paratypes. 1♂, type locality, 28.IX.1989 (larva), reared and emerged on 18. V. 1990, YU (CBM-ZI-33958). 2 pupae (♂♀), Fukumigawa Creek, Matsuyama, Ehime, 16. XI. 1989 (larvae), reared and preserved on 8. II. 1990, YU (CBM-ZI-33959–33960).

Other specimens. Type locality: 1 pupa (♂), 29. III. 1989, YU; 2 pupae (♂♀), 20. IV. 1989, YU; 1 pupa (♂), 23. IV. 1989, YU; 1♂2♀, 28–29. IV. 1989, YU; 11 5th instar larvae, 26. IX. 1989, YU; 2♂, 26. IX. 1989 (larvae), reared and emerged on 7–10. V. 1990, YU; ♂, 28. IX. 1989 (larva), reared and emerged on 18. V. 1990, YU.

Distribution. Shikoku (Ehime).

Etymology. Referring to the type locality.

Remarks. This species is similar to *P. parvus* and *P. kyushuensis*, but distinguishable from the latters in shape of inferior appendage of male genitalia: ventral lobe distinctly thinner than lateral lobe in *P. parvus* whereas both lobes similar in thickness in *P. shikokuensis*; ventral lobe with a long fork in *P. kyushuensis* whereas without fork in *P. shikokuensis.* Female, pupa and larva are indistinguishable from *P. parvus* or *P. kyushuensis.*

Geographical Distribution of the Genus *Palaeagapetus*

Geographical distribution of *Palaeagapetus* in the Asian Far East is summarized in Fig. 5. A male of *P. finisorientis* has been found in South Primorye. *P. flexus* is distributed in Sakhalin, Iturup and central and eastern parts of Hokkaido, whereas *P. ovatus* is distributed in southwestern Hokkaido to northern and central parts of Honshu. The boundary of the two species is present at southern part of Hokkaido (line I in Fig. 5). The two species had been found together in a springstream, Eniwa.

P. parvus is distributed in central and western parts of Honshu. The boundary between *P. parvus* and *P. ovatus* is located at middle Honshu (line II in Fig. 5). It is possible that the boundary may extent to west at mountain area in middle Honshu, as partly shown in Gifu (Fig. 5, circle J). The two species had been found together in two sites, Yunotani-mura, Niigata (circle E) and Ôhikage, Yamanashi (circle I). *P. kyushuensis* and *P. shikokuensis* have been described from Kyushu and Shikoku, respectively. Thus six species of *Palae-*

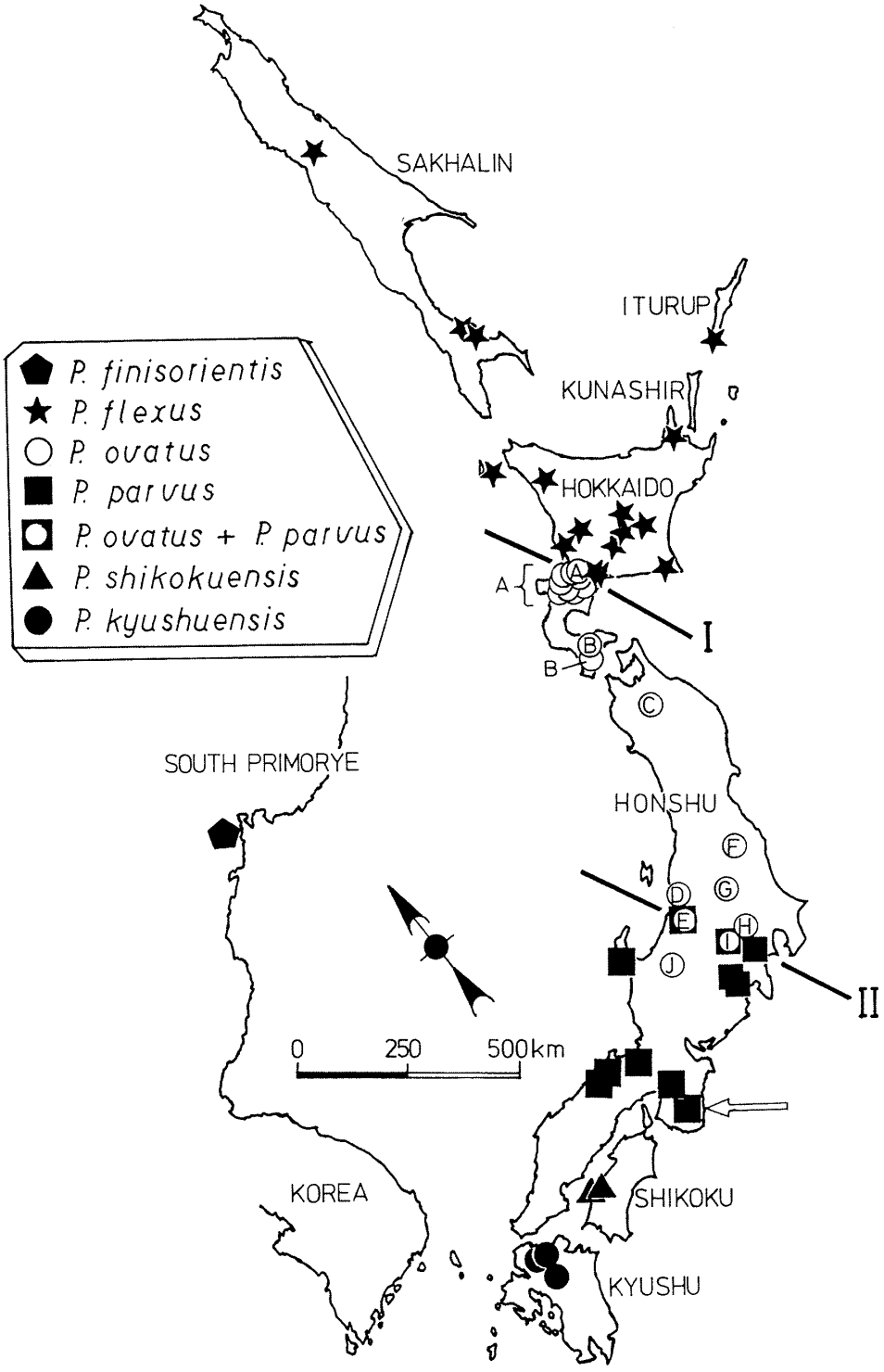

Fig. 5. Geographical distribution of six species of *Palaeagapetus* in the Asian Far East. A–J, variations of male genitalia shown in Fig. 1. Arrow, see text. Solid lines I and II, the boundaries of the neighboring species.

agapetus have been known in the Asian Far East.

In contrast to two species in North America, the genus *Palaeagapetus* is more diverse in the Asian Far East in spite of rather smaller area than North America.

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