

A new species of *Aedes* (Diptera: Culicidae) from Japan

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Abstract: A blood-sucking mosquito of Japan which has been so far designated as *Aedes* (*Edwardsaedes*) *imprimens* (Walker, 1861) is described as a distinct new species. It is considered to represent the second member of the subgenus *Edwardsaedes*.

DESCRIPTION

Aedes bekkui sp. nov.

Aedes imprimens (Walker, 1861); Yamada 1927: 571 (misidentification); LaCasse and Yamaguti 1950: 102; Waku 1950: 69, 1952: 77; Omori 1952: 89; Bekku 1953: 1027, 1954: 1043; Kurihara 1963: 196; Mogi 1976: 309.

A dark brown to brown medium-sized mosquito yellowish brown to white scaled.

FEMALE. Wing 3.4-4.0 mm long. **Head.** Antenna dark brown, a little longer than proboscis, pedicel light brown with small scales and fine setae of dark and pale colour on darker mesal area; flagellomere I, 1.5 length of II, basally pale and with dark and pale scales basomesally, flagellar whorls with 6 dark setae; clypeus dark brown, bare; maxillary palpus dark brown scaled, 0.2 length of proboscis, 5-segmented, segment 5 very minute, occasionally unrecognized; proboscis dark brown scaled, 1.1 length of femur I; eyes narrowly separated; ocular setae dark brown except for median pale ones; vertex covered with pale decumbent narrow curved scales except for an anteromedian patch of dark brown narrow curved scales and a pair of anterolateral patches of dark brown broad scales, and with dark brown to pale erect forked scales; postgena with broad decumbent pale scales intermixed with dark brown ones. **Thorax.** Scutal integument dark brown to brown; scutum covered with yellowish brown decumbent narrow curved scales except for paler ones on anterior promontory, anterolateral scutal fossa, lateral parts including supra-alar and margins of prescutellar bare area; scutellum covered with narrow curved yellowish scales; scutal and prescutal setae dark to pale brown; pleural integument dark brown; anteropronotum with narrow curved and moderately broad yellowish scales and with dark to pale brown setae;

postpronotum with narrow curved yellowish scales dorsally and white broad ones posteroventrally and with pale brown setae along posterior margin; propleuron with a patch of white broad scales and numerous pale brown setae; prosternum, mesomeron and metameron bare; subspiracular area with a patch of white broad scales posteriorly; postspiracular area with a patch of white broad scales and pale brown setae posterodorsally; paratergite bare; mesepisternum with an upper and a lower patch of broad white scales and a row of brown setae along posterior margin; prealar knob with numerous brown setae; mesepimeron with a large patch of broad white scales on middle, numerous brown setae dorsad of the scale patch, lower mesepimeral setae absent. *Legs.* Coxae I-III with brown setae; coxa I with an upper and a lower patch of white broad scales and with brown broad scales between them; coxae II and III with an anteroventral patch of white broad scales; femora I-III with a white apical fringe, basically dark brown scaled dorsally and white scaled ventrally, the white scaled part broader proximally, white scales intermingle into proximal dark scales of femur I and completely replace proximal dark ones in femora II and III; tibiae I-III dark brown scaled except for a narrow basal white scaled band, a ventral white stripe of tibia I and a posterior white stripe of tibia II; tarsi I-III dark brown scaled except for narrow basal white bands on tarsomeres 1-4 of tarsus I and tarsomeres 1-5 of tarsi II and III, these white bands occasionally incomplete or disappeared; posttarsi I-III with 2 ungues of equal size and shape

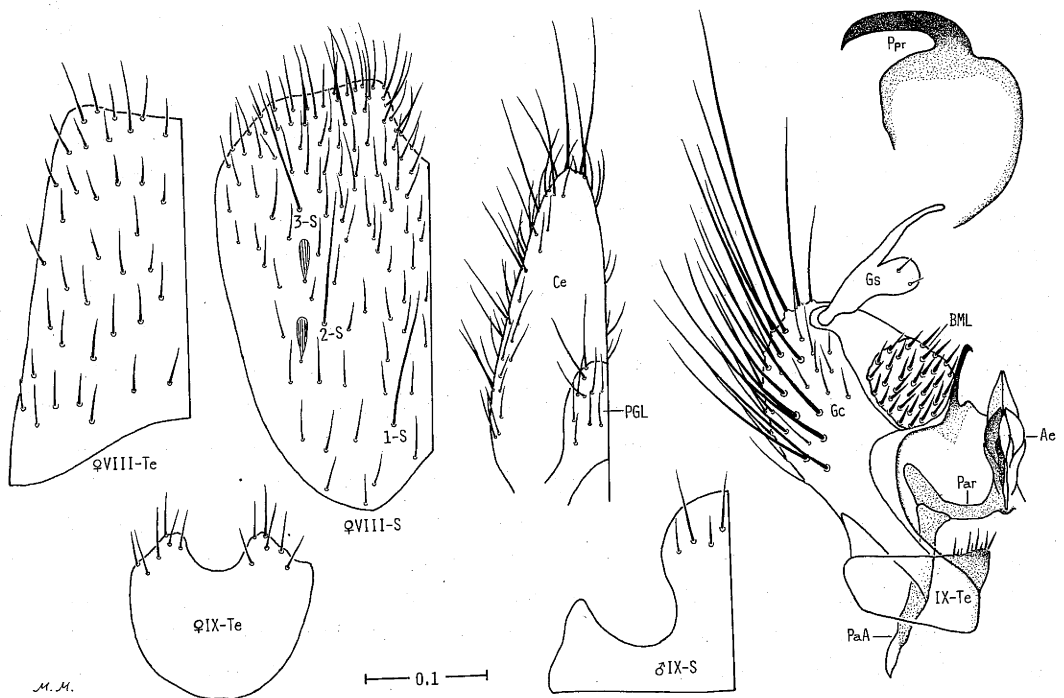


Fig. 1. *Aedes bekkui* sp. nov., male and female genitalia. VIII, IX-Te, terga 8, 9; VIII, IX-S, sternum 8, 9; Ce, cercus; PGL, postgenital lobe; Gc, gonocoxite; Gs, gonostylus; BML, basal mesal lobe, Ae, aedeagus; Ppr, paraproct; Par, paramere; PaA, parameral apodeme. Minute setae are omitted. The scale is in millimeters.

each bearing a tooth. *Wing*. Veins dark brown scaled except for a small white scaled patch at base of costa; alura fringed with narrow brown scales; upper calypter fringed with numerous brown setae. *Halter*. Pedicel dark to pale brown; capitellum dark to pale brown scaled. *Abdomen*. Terga dark brown scaled; I-Te white scaled laterally; II-VIII-Te with a pair of large white scaled patches laterobasally, occasionally a few white scales mediobasally; sterna white scaled; II-VII-S with a dark brown scaled apical band. *Genitalia*. Essentially similar to *Aedes imprimens*; postgenital lobe more slender than *imprimens*, dorsal PGL index slightly larger than 1.0; cercus less slender than *imprimens*, cercus index smaller than 3.5; 1 large and 2 smaller seminal capsules.

MALE. Essentially as in the female but with the following differences. *Wing* 2.7-3.2 mm long. *Head*. Antenna as long as proboscis with numerous long brown setae; flagellar whorls with numerous long brown setae directed mainly dorsoventrally; maxillary palpus 1.2-1.3 length of proboscis, 5-segmented, segment 5 upturned, segment 5 and distal part of segment 4 with numerous long brown erect setae on lateral and ventral surfaces; vertex without dark brown scales. *Thorax*. Postpronotum with much smaller numbers of narrow curved and broad white scales; propleuron and postspiracular area without scales. *Legs*. White scaling reduced; tarsi I and II without basal white bands; posttarsi I and II with ungues of strongly unequal size and shape; posttarsi III with ungues of weakly unequal size and shape. *Wing*. Pale scaled spot at base of costa reduced. *Abdomen*. II-VII-Te brown scaled with a dorsobasal white scaled band somewhat narrower mesally; I-VII-Te with numerous long brown setae laterally; VIII-Te white scaled with a row of short stout setae along the apical margin; II-VII-S white scaled except for a distal dark brown scaled band; VIII-S dark scaled more broadly. *Genitalia*. IX-Te consists of 2 transverse lateral plates, caudomesal margin of each plate with short setae and occasionally weakly lobed, median area between plates membranous; gonocoxite very short, broad and rounded, surface with many long setae except for a few short ones on dorsomesal and ventrobasal parts, laterally with a few broad scales; gonostylus 0.6 length of gonocoxite, bifurcated, outer arm long and narrow, inner one short, broad, rounded and with a few short setae, gonostylar claw absent; basal mesal lobe broad, dorsally with numerous short thick setae; apical area of paraproct forming a very heavily pigmented claw, cercal setae absent; cercal sclerite narrow; aedeagus narrow, apex sagittate, base narrowly divided into 2 narrow plates each with a few dorsobasal teeth, paramere and parameral apodeme long; IX-S caudomesally with a few short setae.

PUPA. Chaetotaxy as figured and tabulated. Ocular plate without cuticular facets. *Respiratory trumpet* heavily pigmented, index 3.4 (2.8-4.3). *Cephalothorax*. 1,3-CT approximately equally developed. *Metanotal plate*. 10-CT usually caudad and mesad, rarely directly caudad of 11-CT. *Abdomen*. 2, 3-I rather approximated, the distance between them 3 (1.5-5.0) times as long as the diameter of basal punctures of 2-I; 9-VII directly cephalad of 6-VII; 9-VIII well developed. *Paddle* ovoid, index 1.4 (1.2-1.6) with minute serrations on outer margin of butress and minute spicules on apical margin; midrib does not reach apex; 1-P short.

LARVA. Chaetotaxy as figured and tabulated. *Head*. Integument inconspicuously sculptured with minute elongated spots arranged in meshes; 4-C mesad, 7-C laterad and both

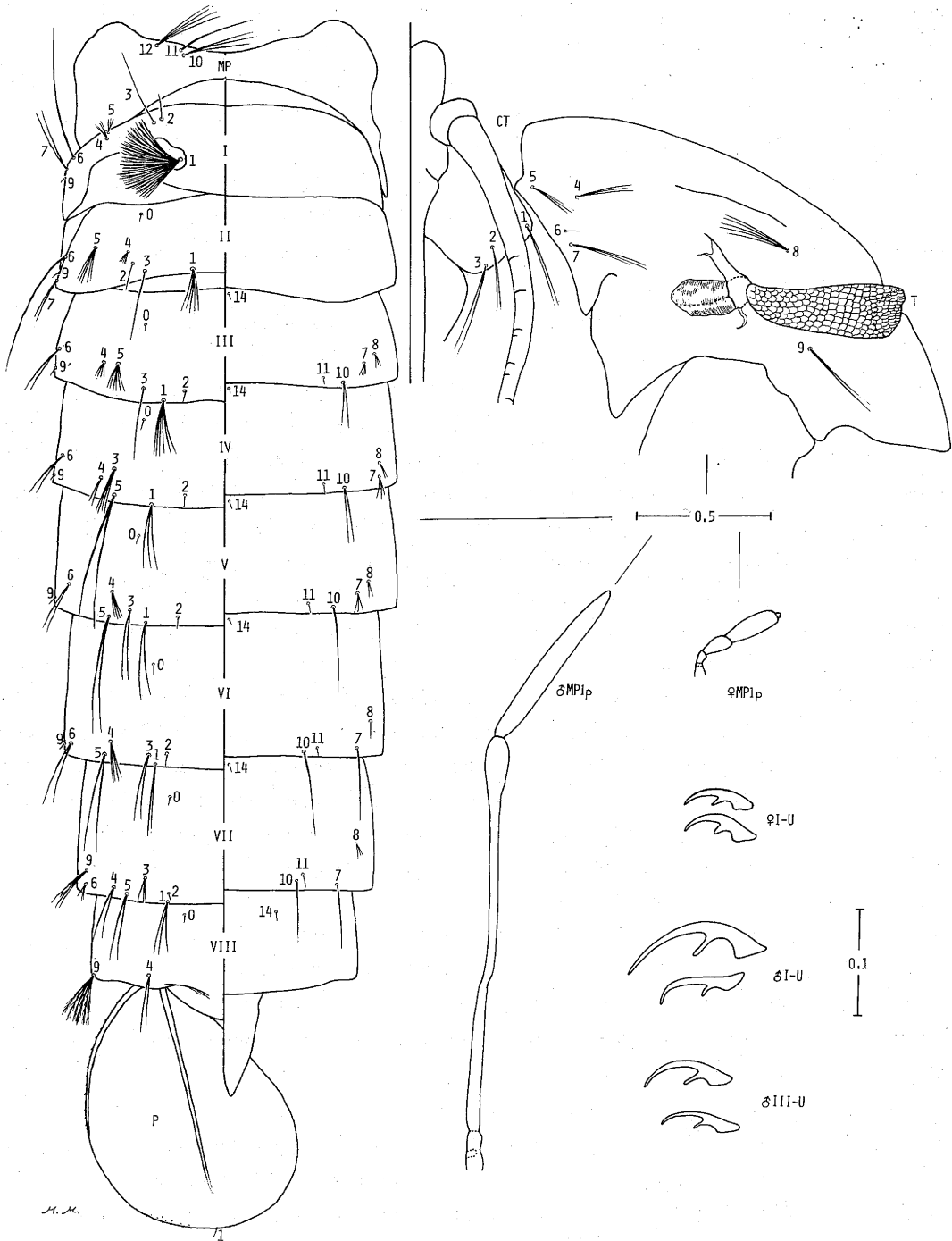


Fig. 2. *Aedes bekkui* sp. nov., adults and pupa. MPlp, maxillary palpus (setae and scales are omitted); I, III-U, unguis 1, 3; CT, cephalothorax; MP, metanotal plate; T, respiratory trumpet; I-VIII, abdominal segments 1-8; P, paddle. Scales are in millimeters.

Table 1. Caetotaxy of the pupa of *Aedes bekkui* sp. nov.

Setae No.	Cephalothorax	Abdomen							
		I	II	III	IV	V	VI	VII	VIII
0	—	—	1	1	1	1	1	1	1
1	1-2	m(B)	1-6-7	3-6-9	2-3-6	2-4	2-4	1-3-4	—
2	1-2-3	1	1	1	1	1	1	1	—
3	1-2-4	1	1	1	3-4-6	2-4	2-3	2-5-6	—
4	1-3-5	3-4-6	2-4-7	3-4-5	2-7	2-4-6	2-4-5	2-5	2-3
5	2-3-6	3-5	4-5-8	4-7-9	1-2	2-3	2	2-3	—
6	1-2	1-2	1	2-4	2-4	2-3	1-2	2-3-5	—
7	1-3-5	1-2-3	2-3	2-4	2-3-5	2-4-5	1-3	1	—
8	4-5-7	—	—	2-3-6	2-3	1-2-3	1-4	1-3-4	—
9	2-3	1	1	1	1	1	1	1-3-4(b)	4-6-8(B)
10	3-5	—	—	1-2-4	1-2-3	1-2	1	1	—
11	1-2	—	—	1	1	1	1	1-2	—
12	2-4-6	—	—	—	—	—	—	—	1-P
13	—	—	—	—	—	—	—	—	1
14	—	—	—	1	1	1	1	1	1

10 individuals were examined. Gothic figures show modes.

B: barbed; b: weakly barbed; m: multiple (with more than 10 branches)

cephalad of 6-C; 6-C laterad and slightly cephalad of 5-C; dorsomentum heavily pigmented with 33-37 teeth, ventromedian cervical sclerite moderately pigmented. *Antenna* long, slender, moderately pigmented with numerous spines; 1-A attached to about middle of antenna; 2-A with a subapical constriction; 5-A flat, apically membranous. *Thorax*. 9-12-M, T on large heavily pigmented plates with a large apical spine and a few smaller ones. *Abdomen*. 6-I-IV, 7-I, II on a small heavily pigmented plate; 13-VII not widely separated from 10-VII; 1, 2-VIII on a common small pigmented plate; comb consists of 7-12 scales arranged in 2 irregular rows, each scale with a long median apical spine and many short laterobasal denticles; saddle heavily pigmented, incomplete without acus; anal papillae long, tapered; 3-X single, 2.5 length of 2-X; 4-5 precratal setae. *Siphon* heavily pigmented with well developed acus, index 3.7 (3.3-3.9); pecten on basal 0.6 of siphon, consists of 17-19 teeth, a few apical teeth more widely spaced than remainder, each tooth with a large denticle and occasionally an additional minute one except for distal 1-2 teeth which usually lack denticles; 1-S just distad of and as long as apical pecten teeth.

TYPE-LOCALITY. Sao-zaki, Kami-agata, Tsushima Island, Japan.

TYPE-SERIES. Holotype: Male with an associated slide of genitalia, 15 VI 1976, found as 4th instar larva in a ground pool, M. Mogi. Paratypes: 10 males and 10 females with associated slides of genitalia (3 males and 3 females) and of head plus legs (1 male and 1 female), 10 pupal skins, 10 larvae, same data as the holotype; 10 larvae, 18 VII 1976, in the same ground pool where the holotype and other paratypes were found, M. Mogi. The types will be preserved in the National Science Museum, Tokyo, except for each set of 1 male, 1 female, 1 pupal skin and 1 larva from the paratypes, which will be presented to the

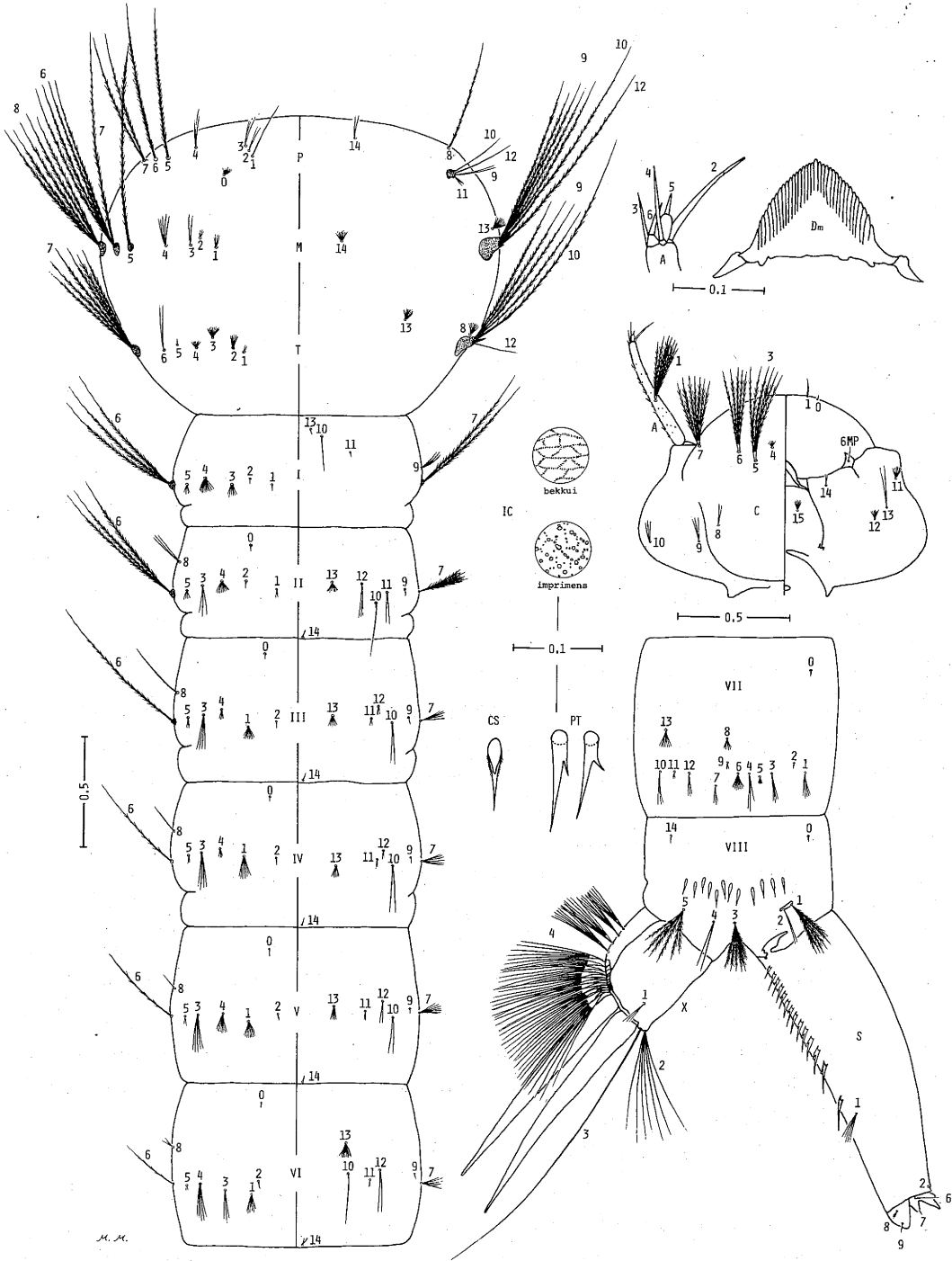


Fig. 3. *Aedes bekkui* sp. nov., 4th instar larva with a figure of head integument of *Aedes imprimens*. A, antenna; C, head; IC, head integument; Dm, dorsomentum; P, prothorax; M, mesothorax; T, metathorax; I-VIII, X, abdominal segments 1-8, 10; CS, comb scale; S, siphon; PT, pecten teeth. Scales are in millimeters.

Table 2. Chaetotaxy of the 4th instar larva of *Aedes bekkui* sp. nov.

Setae No.	Antenna	Head	Thorax			Abdomen										
			Pro-	Meso-	Meta-	I	II	III	IV	V	VI	VII	VIII			
0	—	1	m	—	—	—	1	1	1	1	1	1	1	1	1	1
1	5-7-10(B)	1	1-2	1-4-5	1-2-3	1	1-2-4	7-10-11	5-9-11	6-9-11	6-8-11	6-8-11	4-7-10	6-7-9(B)		
2	1	—	2-3	2-4	3-5	1	1	1	1	1	1	1	1	2-3-5		
3	1	1	3-4	2-4	8-12-14	3-7	4-7	3-5-6	4-6	2-4-6	2-3-8	2-3-8	5-7-9	6-7-9(B)		
4	1	5-7-9	2-3	3-6-7	3-8-9	m	m	3-5-7	2-4-7	7-8-12	4-5-9	2-3-4	2-3			
5	1	5-6-7(B)	1(B)	1-2(B)	1	3-4-6	2-4-5	1-3	2-3	1-2-3	1-3-5	4-5-8	4-6-8(B)			
6	1	4-5-7(B)	1(B)	2-4-5(B)	1-2-3	2-3-4(B)	2-3-4(B)	1-2(B)	1(b)	1(b)	1-2(b)	6-10-11				
7	—	7-11(B)	2-3(B)	1(B)	4-7-10(B)	1-2(B)	4-6(B)	2-7-9	5-6-11	4-7-10	5-7	3-4				
8	—	2-3	1-3(B)	5-6-7(B)	m	—	2-3-4	1-3	1	1	1-3-5	4-7-9				
9	—	2-3	2	3-5-6(B)	2-4-6(B)	2-3-4	1	1	1	1	1	2-3				
10	—	2-3-4	1	1(B)	1(B)	1-2	1-2	2-3	1-2	2	1	2-4				
11	—	6-8-10	1-3-5	1	1	1-2	1-2-3	2-3	2-4	1-2-3	2-4	1-3				
12	—	4-7-8	1	1(B)	1(B)	—	2-3-4	2-3-4	2-4	1-2-3	1-2-3	3-4				
13	—	1-2-4	—	m	m	1	m	5-8-9	4-6-9	4-6	m	5-8-13				
14	—	1-2-3	1-2	m	—	—	—	1	1	1	1-2	1-2				
15	—	4-6-7	—	—	—	—	—	—	—	—	—	—				

10 individuals were examined. Gothic figures show modes.

B: barbed; b: weakly barbed; m: multiple (with more than 10 branches)

1-S
5-6-10
1-X
1-3-4
2-X
6-7-8
3-X
1
4-X
13-14-15

U. S. National Museum and the British Museum (Natural History) respectively.

SPECIMENS EXAMINED OTHER THAN TYPES. 4 females, 23 VI 1954, Kushimazaki, Omura, Nagasaki Pref., Kyushu, Japan, N. Omori and H. Bekku. They are a part of the series reported by Omori (1952) and Bekku (1953, 1954).

DISTRIBUTION FROM LITERATURE. The following are records of *imprimens* sensu Yamada (1927) from Japan. An asterisk indicates that at least some parts of the stages are figured. Kanayama, Kamikawa Dist., Hokkaido, and Omura, Nagasaki Pref., Kyushu; Yamada 1927: 571—Omura (based upon Yamada's specimens); LaCasse and Yamaguti 1950: 102 (♀*, ♂) — Kanayama and Omura (based upon Yamada's specimens); Kurihara 1963: 196 (A*) — Sendai, Miyagi Pref., Honshu; Waku 1950: 69 (♀*, ♂*, ♂G*, P*), 1952: 77 (L*, E*) — Kanazawa, Ishikawa Pref., Honshu; Tamaboko 1953: 7 — Urawa, Saitama Pref., Honshu and an unwritten locality in Hokkaido; Hara 1957: 65 (♀G*) — Ise, Mie Pref., Honshu; Sakakibara 1959: 39 — Niigata Pref., Honshu and Nagasaki Pref., Kyushu; Kamimura 1968: 18 — Kita-urawa, Saitama Pref., Honshu; Moriya *et al.* 1973: 54 (E*) — Akigase, Nagano Pref., Honshu; Reinert 1976: 18.

Records from Kanayama, Omura and Sendai have sufficient description and figures for judging that they are certainly referable to *bekkui*. Yamaguti and LaCasse's unpublished figures (♀G, ♂G, ♂ palpus) which will be included in Tanaka *et al.* (in press) may be also based upon Yamada's specimens from Kanayama or Omura. Other records will possibly be proven to be referable to *bekkui* by further collections or the re-examination of the preserved specimens. Records from South Korea (Reisen *et al.*, 1971) may be also proven to be referable to *bekkui* through the same procedures.

DISTRIBUTION. At present definitely known only from Japan: Hokkaido, Honshu, Kyushu and Tsushima.

TAXONOMIC DISCUSSION. The subgenus *Edwardsaedes* Belkin, 1962 has been a monotypic one erected for *Aedes imprimens* (Walker, 1861). The above described new species which has been so far misidentified as *Aedes imprimens* does not coincide with the subgeneric diagnoses for *Edwardsaedes* given by Reinert (1976) in the following respects (Reinert's description in parentheses): in the adults, subspiracular area without short fine setae (with short fine setae); in the pupa, 10-CT usually mesad of 11-CT (laterad), 2, 3-I rather approximated (widely separated); and in the larva, 4-C slightly cephalad of 6-C (far cephalad), saddle incomplete (complete), 3-X single and much longer than 2-X (multiple and slightly longer). The discrepancy is slight in the adults. No significant differences are found in the basic structure of male and female genitalia. But in the immature stages the discrepancy is very large. These stages of *bekkui* coincide with the subgenus *Aedimorphus* and possibly with some other subgenera better. I can not find any differences from the larval and pupal character of *Aedimorphus* described by Belkin (1962: 423) and from that of Southeast Asian *Aedimorphus* described by Reinert (1973: 7) except for larval thorax with well developed meso- and metapleural tubercles. Therefore the determination of the subgeneric status of *bekkui* is not necessarily very easy. At present I consider that it is natural to include *bekkui* in the subgenus *Edwardsaedes* by partly revising the definition for *Edwardsaedes*, attaching importance to the complete

coincidence of male and female genitalia of *bekkui* with those of *Edwardsaedes* which are distinct from related subgenera. The situation may be somewhat similar to the case of *Aedes* (*Neomelani-conion*) *lineatopennis* (Ludlow). According to Reinert (1973: 11), the larva of this species is so similar to the subgenus *Aedimorphus* that any subgeneric differences can not be found, although the adults, especially the males of them are distinct each other. Whether this similarity in the immature stages of *bekkui* and *lineatopennis* to the subgenus *Aedimorphus* indicates the phylogenetic affinity of these species to *Aedimorphus* or it is a result of convergent evolution is a very interesting problem. It may be worth adding here that a part of the above mentioned character of the subgenus *Edwardsaedes* based upon *imprimens* seems to be more or less variable in *imprimens* insofar as I can judge from a few specimens from Thailand and various author's description. For example the description and attached figures by Mattingly (1961: 10 and 55) show that pupal setae 2,3-I of a few specimens from Malaysia are as equally approximated as those of *bekkui*.

The other character effective for separating the two species is as follows (in parentheses for *imprimens* after Reinert (1976) unless otherwise noted): in the female, the body smaller (wing 4.7 mm long after Belkin, 1962 and 3-5 mm after Mattingly, 1961), postpronotum with broad scales posteroventrally (occasionally with a few broad scales), II-VII-Te usually without a distinct dorsobasal white scaled band (at least II-IV-Te with a distinct dorsobasal band); in the female genitalia, postgenital lobe more slender, dorsal PGL index larger than 1.0 (smaller than 1.0), cercus less slender, index smaller than 3.5 (larger than 3.5); in the male, the body smaller (wing 5 mm long after Knight and Hull, 1953 and 3.5-5 mm after Mattingly, 1961), dorsobasal white scaled bands of II-VII-Te somewhat narrower mesally (broader mesally); in the male genitalia, caudomesal lobes of IX-Te at most weakly developed (strongly developed), inner arm of gonostylus rounded (not rounded); in the larva, head integument with inconspicuous sculpture of minute elongated spots arranged in meshes (with conspicuous sculpture of roundish spots of various sizes arranged rather at random except for anterior parts), dorsomentum with 33-37 teeth (41-43 teeth), 6,8-IV, V single (usually double to triple), saddle without spines (with spines), I-X usually triple (single), I-S and apical pecten teeth about equal in length (I-S longer, apical pecten teeth shorter, so the former is double length of the latter after various authors' figures and a few specimens from Thailand available for me).

Apparently the long misidentification of this distinct species as *imprimens* since Yamada (1927) should be merely attributed to the facts that the sufficient description of *imprimens* including various stages did not appear before Knight and Hull (1953) and that *bekkui* is one of the rarest species among Japanese mosquitoes. The most previous records of *bekkui* as *imprimens* sensu Yamada (1927) from Japan include only females in which the differences from *imprimens* can not be so easily convinced of by being compared with the description of *imprimens*.

The subgenera related to *Edwardsaedes* are primarily or entirely tropical in their distributions. Therefore it may be reasonable to assume that *Edwardsaedes* which is represented only by tropical *imprimens* and temperate *bekkui* at present was originally tropical and that *bekkui* is a temperate form derived from a common tropical ancestor of the two species. This

assumption coincides well with one of the main trends in the mosquito speciation, *ie.*, the derivation of northern forms from tropical ancestors, which was clearly shown by Ross (1964). In view of our present knowledge on the climatic change during the Quaternary of Japan (e. g., Tsukada, 1974: 89), we can not find an age sufficiently warm for the invasion of the tropical ancestor after about 0.4 million years ago (middle Pleistocene), at the latest since when the adaptation of a part of the ancestral tropical species to a temperate climate may have started following the change of the climate to a temperate one. If this assumption is correct, the specific differences between *bekkui* and *imprimens* may have been formed at least during this 0.4 million years' segregation.

MEDICAL IMPORTANCE. *Aedes bekkui* is an active feeder on man during daytime and at night in the vicinity of larval breeding places (Bekku, 1953, 1954 and my observations at the type-locality). But the species is so local in its distribution that it has no practical importance at least in Japan. The experimental results that Japanese "*imprimens*" was unsuitable for the development of *Wuchereria bancrofti* (Cobbold) (Yamada, 1927) should be confined to *bekkui* and not be applied to true *imprimens*.

BIOLOGICAL NOTES. Larvae breed in temporary ground pools in forests and bushes (Waku, 1950, 1952; Omori, 1952). Associated larvae were *Aedes vexans nipponii*, *A. esoensis*, *A. alboscutellatus* (Waku, 1950), *Aedes nobukonis* (Omori, 1952) and *Aedes vexans nipponii*, *A. japonicus* at the type-locality. Bekku (1953, 1954) collected females from May to September by biting collections. Waku (1952) stated that eggs laid in autumn did not hatch until next spring.

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日本産ヤブカ属の1新種 (双翅目: 蚊科)

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山田 (1927) 以来, *Aedes imprimens* (Walker, 1861) と同定されてきたヤブカ属の1邦産種は, インドネシアを中心とする東南アジアの熱帯地方およびニューギニアに分布する真の *imprimens* とは全く別の種であることが判明したので, 新種 *Aedes bekkui* として成虫 (雌, 雄), 蛹および幼虫の形態を記載した. 熱帯産の *imprimens* は, ただ1種で *Edwardsaedes* 亜属を構成する特異な種であるが, *bekkui* の蛹および幼虫の形態は, *imprimens* にもとづく *Edwardsaedes* 亜属の記載とは, いくつかの重要な点で相違し, むしろ *Aedimorphus* 亜属とよく一致する. しかし, 雌, 雄成虫の生殖器の構造が *Edwardsaedes* 亜属とよく一致し, 近縁亜属から区別できる点を重視して, *bekkui* を, *Edwardsaedes* 亜属の2番目の種とみなすのが妥当であると思われる. *bekkui* の確実な記録は今のところ日本本土に限られる. 幼虫は林間の水溜りに発生し, その近辺では人から激しく吸血するが, 分布が局地的なために衛生害虫としての重要性は少ない.

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