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**A TAXONOMIC REVIEW OF THE PHYTOPHAGOUS LADYBIRD  
BEETLES OF THE DIEKEANA ALTERNANS COMPLEX (COLEOPTERA:  
COCCINELLIDAE: EPILACHNINI) WITH DESCRIPTIONS OF EIGHT NEW  
SPECIES AND ONE NEW SUBSPECIES**

By YURI OHTA-MATSUBAYASHI, HARUO KATAKURA, SIH KAHONO AND NAMIKI KIKUCHI

*Abstract*

OHTA-MATSUBAYASHI, Y., KATAKURA, H., KAHONO, S. and KIKUCHI, N. 2017. A taxonomic review of the phytophagous ladybird beetles of the *Diekeana alternans* complex (Coleoptera: Coccinellidae: Epilachnini) with descriptions of eight new species and one new subspecies. *Ins. matsum. n. s.* 73: 1–37, 14 figs, 1 table, 3 online supplementary figs.

A group of phytophagous ladybird beetles utilizing diverse host plants in South and Southeast Asia was reviewed as the *Diekeana alternans* complex. Ten species (one with two subspecies) including seven new species and one new subspecies were described or redescribed under this species complex. *Diekeana hopeiana* (Miyatake) was synonymized with *D. grayi* (Mulsant). Two other species were also incorporated into this complex based on literature information. Additionally, another species closely related to this species complex was described as new to science. Species of the *D. alternans* complex constituted a part of the *Diekeana admirabilis* group and were characterized by a “blade” situated at the apical part of penis of male genitalia. Almost all the species could be identified by the species-specific conditions of male genitalia. The species that utilize cucurbitaceous plants of the tribes Benincaseae, Sicyoeae and/or Cucurbitaeae were widespread in South and Southeast Asia comprising at least four allopatric species. On the other hand, the species specialized to other taxonomic groups of host plants were localized in either Sumatra or Java with a possible exception of *D. glochinosa* (Pang & Mao) in South China. They often sympatrically occurred with each other or with one of the cucurbitaceous plant feeders.

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## INTRODUCTION

Phytophagous ladybird beetles comprise approximately 1,000 species worldwide (Jadwiszczak & Węgrzynowicz 2003). They were formerly treated as a subfamily, Epilachninae, within the family Coccinellidae, but are now treated as the tribe Epilachnini in the newly defined subfamily Coccinellinae (Seago *et al.* 2011). Although their host plants are diverse, covering various families of angiosperms such as Acanthaceae, Asteraceae, Cucurbitaceae, Fabaceae, Lamiaceae, Poaceae, Ranunculaceae, Solanaceae, Urticaceae, and Vitaceae (Pang & Mao 1979; Schaefer 1983; Katakura *et al.* 2001; Katoh *et al.* 2014), each species of epilachnine beetles is usually host specific, being dependent on a narrow range of host plants. Thus, this group of beetles is potentially suitable for the study of evolutionary interactions between herbivores and their host plants, and some species groups have actually been the subjects of intensive studies on the evolution of host specificity and its relation to speciation (cf. Katakura 1997; Katakura *et al.* 1989; Matsubayashi & Katakura 2009; Matsubayashi *et al.* 2011, 2013; Ueno *et al.* 2017). Some epilachnine beetles are also known as pests of important crops (cf. Schaefer 1983). At the present, however, our knowledge of the taxonomy and biology of Asian Epilachnini is still limited, and it is particularly poor for the species in the tropic region where the biodiversity is believed to be the world's highest.

In a list of epilachnine ladybird beetles of Sumatra and Java, Katakura *et al.* (2001) recorded one species of the genus *Epilachna* widespread in hilly or mountain regions of Sumatra and Java as *Epilachna alternans* Mulsant, 1850. They also recorded two additional forms, *Epilachna* sp. I and *E.* sp. L, from Sumatra as putative undescribed species related to *E. alternans*. Subsequent studies have revealed that *E. alternans* of Katakura *et al.* (2001) is actually composed of multiple species, which are different in detailed morphology of male genitalia, host plants and/or localities. Moreover, some undescribed species of this species complex depending on host plants different from those previously known have been newly discovered. In this paper, we make a taxonomic review of *Epilachna alternans* s.str. and its related forms in the Asian tropics on the basis of morphology, geographic distribution ranges, and host plants.

In the following, the generic classification followed Szawaryn *et al.* (2015), who revised the genera of world Epilachnini and established a number of new genera. Adopting this new generic classification system, we place all the species treated in this paper in the genus *Diekeana* Tomaszewska & Szawaryn in Szawaryn *et al.* (2015) (also see, Tomaszewska & Szawaryn 2016), that was established for a part of Asian members of the genus *Epilachna* Chevrolat in Dejean, 1837 (*sensu* Li & Cook 1961), with the type species *Epilachna alternans* Mulsant, 1850.

All the species of this group thus far known from Sumatra and Java (except for *Epilachna* sp. L from Sumatra for which only one female was available) are arranged into the *Diekeana alternans* complex, together with *Diekeana grayi* (Mulsant, 1850) comb. nov. originally described from Bengal, India, and *Diekeana concuogensis* (Hoang, 1978) comb. nov. known from northern parts of Vietnam. Two species, *D. grayi* and *D. alternans*, are redescribed based on the type specimens and materials newly obtained by us. The type specimens of *Epilachna hopeiana* Miyatake (1985) described from Nepal were also examined and we treat this species as a junior synonym of *D. grayi*. *Diekeana concuogensis* is redescribed based on new materials. Seven species and one subspecies of the *D. alternans* complex and one species close to this species complex are

described as new to science. Consequently, the *D. alternans* complex treated in this study comprises at least 10 species, one of which is composed of two subspecies. In addition, *Diekeana glochinosa* (Pang & Mao, 1979) and *Diekeana bocaki* (Pang & Ślipiński, 2012) comb. nov. in Pang *et al.* (2012), not examined in the present study, are placed in this species complex. Another species closely related to this species complex was also described as new to science.

## MATERIALS AND METHODS

### *Materials*

The type materials were borrowed from the following institute and museums: *Epilachna alternans* Mulsant, Haag Collection, German Entomological Institute, (DEI); *Epilachna grayi* Mulsant, Hope Collection, Oxford University Museum (OXUM) and Natural History Museum in London (NHML); *Epilachna hopeiana* Miyatake, the Hokkaido University Museum (SEHU). The female specimen that was identified as *E. grayi* by Miyatake (1985) was also borrowed from SEHU. Other specimens treated in the present study were collected by the collaboration of H. Katakura and his co-workers during 1989 to 2012 in Java and Sumatra, Indonesia, and a few localities in Vietnam and Nepal, with permission of local authorities. Half of the specimens collected in Indonesia, including the holotypes, will be deposited in Bogor Zoological Museum (MZB), Indonesia, and the rest in the Systematic Entomology Section, the Hokkaido University Museum (SEHU), Sapporo, Japan.

### *Methods*

Specimens examined were pinned dry ones or kept in absolute ethanol or Kahle's solution (ethanol/formalin/acetic acid/water = 17/6/2/28 in volume). Male and female genitalia were examined after maceration in 10% KOH. Measurements of body length were undertaken under a binocular dissecting microscope equipped with an ocular micrometer. Photos were taken using digital cameras. Composite images of the whole body were produced using a built-in function of a digital camera (Olympus OMD EM-1 mk2), and those of some body parts and genitalia were produced by using Zerene Stacker. Final plates were prepared using Adobe Illustrator CS4.

### *Terminology*

Terminology principally followed Ślipiński (2007) and Ślipiński and Tomaszewska (2010). Some terms followed Dieke (1947). Elytral spots were numbered as 1–6 (Fig. 1A). In addition, we defined various parts of penis (= siphon) as follows (Fig. 1B–D): The distal portion is similar to the “blade” of a knife, with an “edge” on the ventral side and a distinctly angulated “basal corner”. The “basal corner” may be acute and somewhat pointed toward the base of penis, and Katakura *et al.* (2001) called such a condition of basal corner as a “hook”. In this paper, we may refer to the acute basal corner as “thorn”. The part of penis just proximal to the blade is usually narrowed. We named the narrowed part of penis as “neck”. We call the distance from the narrowest part of neck to the distal end of penis as “blade length (BL)”, the largest longitudinal width of the blade as “blade width (BW)”, the depth of the edge at the basal corner (distance between the level of basal corner and the ventral side of the narrowest part of neck) as “edge depth (ED)”, the narrowest longitudinal width of the neck as “neck width (NW)”, the distance between

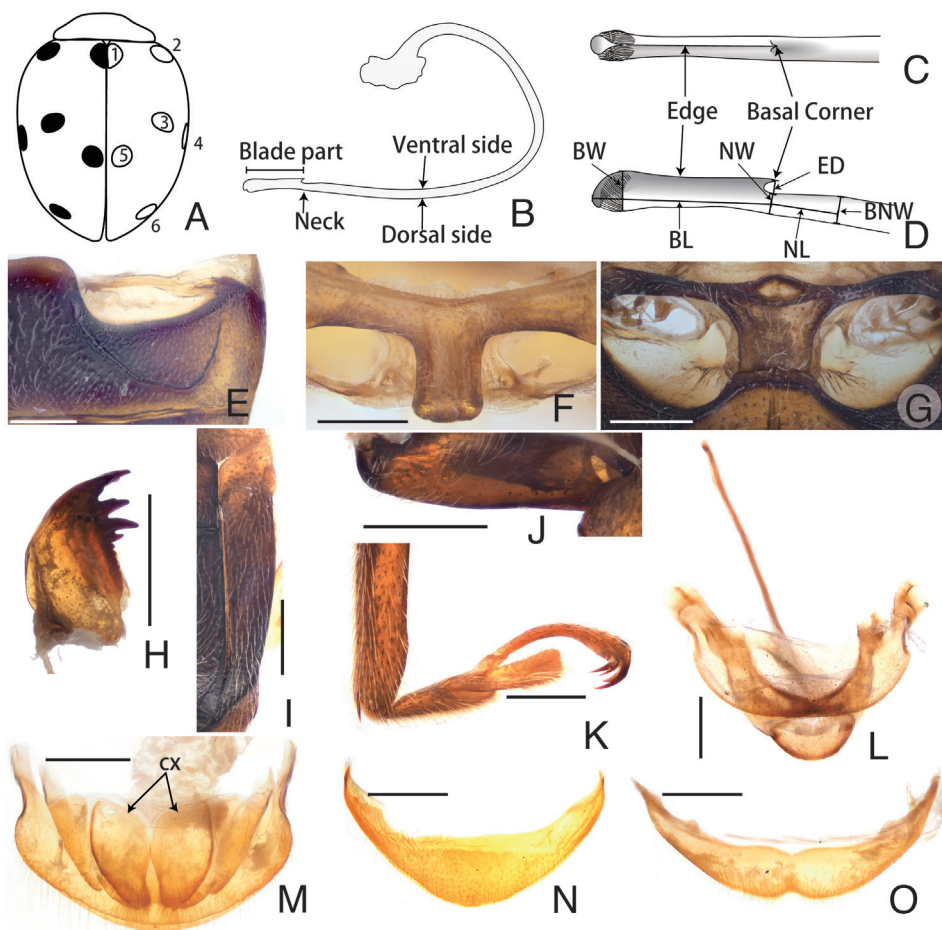


Fig. 1. General morphological features of the *Diekeana alternans* complex. A, positions and numberings of elytral spots. B, penis. C, D, apex of penis: BL, blade length; BW, blade width; EG, edge depth; NL, neck length; NW, neck width; BNW, basal neck width. E, part of ventrites 1 and 2, showing femoral line. F, prosternal process. G, metaventral postcoxal line. H, mandible. I, metanepisternum. J, posterior part of left hind coxa. K, left hind tibia and tarsus. L, male terminalia. M, female terminalia and genitalia (part): cx, coxite. N, ventrite 6 (female). O, ventrite 6 (male). E–O, *Diekeana alternans* from Cibodas, West Java. Scale bars, 1 mm.

the level of the neck width and the point where the penis narrowed toward the apex as “neck length (NL)”, and the width at the point where the penis narrowed toward the apex as “basal neck width (BNW)”. In the description of each species, the following values measured for the figured specimens are given: BL/BW, ED/NW, NL/BNW, NW/BNW.

#### DESCRIPTIONS

According to Szawaryn *et al.* (2015) and Tomaszewska and Szawaryn (2016) who made a worldwide revision of the genera of Epilachnini, *Diekeana* forms a clade with

*Uniparodentata* Wang et Cao, 1993 (= *Ryszardia* Tomaszewska & Szawaryn in Szawaryn *et al.* 2015), which is characterized by the presence of serration along inner margin of metanepisternum and the prosternal process most often with lateral carinae. *Diekeana* differs from *Uniparodentata* as follows (corresponding conditions in *Uniparodentata* in parentheses): the mandibular incisor edge multidentate (smooth), epipleuron without foveae (with foveae for the reception of femora), mid and hind coxae simple (with small tubercles on inner surface), metaventral postcoxal lines joined on metaventral process (separate), tibiae without oblique carina near apex (with oblique carina near apex), coxites spindle-shaped (subtriangular or subtrapezoidal), and female tergite X simple (bent over) (Szawaryn *et al.* 2015, Tomaszewska & Szawaryn 2016, Katakura & Kahono 2016).

All the members of the *Diekeana alternans* complex here treated are essentially similar in general morphology in both sexes, and may fit to previous descriptions under the names of *Epilachna grayi*, *E. alternans*, *E. glochinosa*, *E. concuongensis*, *E. hopeiana* and *E. bocaki* except for the details of male genitalia and some other morphological features. In this section, the general features of the *D. alternans* complex are given first by supplementing and largely modifying the description of *E. hopeiana* by Miyatake (1985), with reference to *D. alternans* and other species when necessary. Then the descriptions of respective species follow. In the descriptions of respective species, we provide only the diagnostically important morphological characters and body size. Known distribution ranges and host plants are also given in the descriptions (also cf. Fig. 14 and Table 1).

#### General morphological features of the *Diekeana alternans* complex

*Diagnosis:* A series of species belonging to the *Diekeana admirabilis* group defined by Dieke (1947). Discriminated from other species of the *D. admirabilis* group by the knife-blade like structure at the distal portion of penis. Female genitalia are of *Diekeana admirabilis* type, with spindle-shaped coxites.

*Body* (Figs 2 & 3): Generally oval, moderately convex, highest at center of body; sometimes elongated oval, elliptical, or very humped.

*Color and maculation:* Body reddish or somewhat yellowish testaceous; pronotum with or without blackish spots, or medially darker; elytra each with six black spots in variable size and shape: Spot 1 entirely or partly touching suture, connecting with counterpart; spot 4 entirely or partly touching margin; spot 5 usually entirely or partly touching suture, connecting with counterpart. Spots 1-2 and/or (5-)3-4 often coalescing (Figs 2 & 3). Underside of the body usually reddish or yellowish brown, with blackish areas on posterior corners of metaventrite and on middle of elytral epipleura; abdominal ventrites often blackish to some extent. Pubescence of body surface grayish or yellowish except generally blackish brown (sometimes grayish) one on the blackish spots.

Head equipped with finely impressed punctures and dense pubescence; eyes finely faceted; antennae nearly as long as or shorter than width of head, with three terminal segments forming subserrate club; labrum emarginate in front, with yellowish hairs; mandible (Fig. 1H) multidentate, incisor edge with multiple denticles. Pronotum more than two times wider than median length, broadly emarginate in front, with anterior corners rectangularly rounded and posterior corners obtusely or almost rectangularly

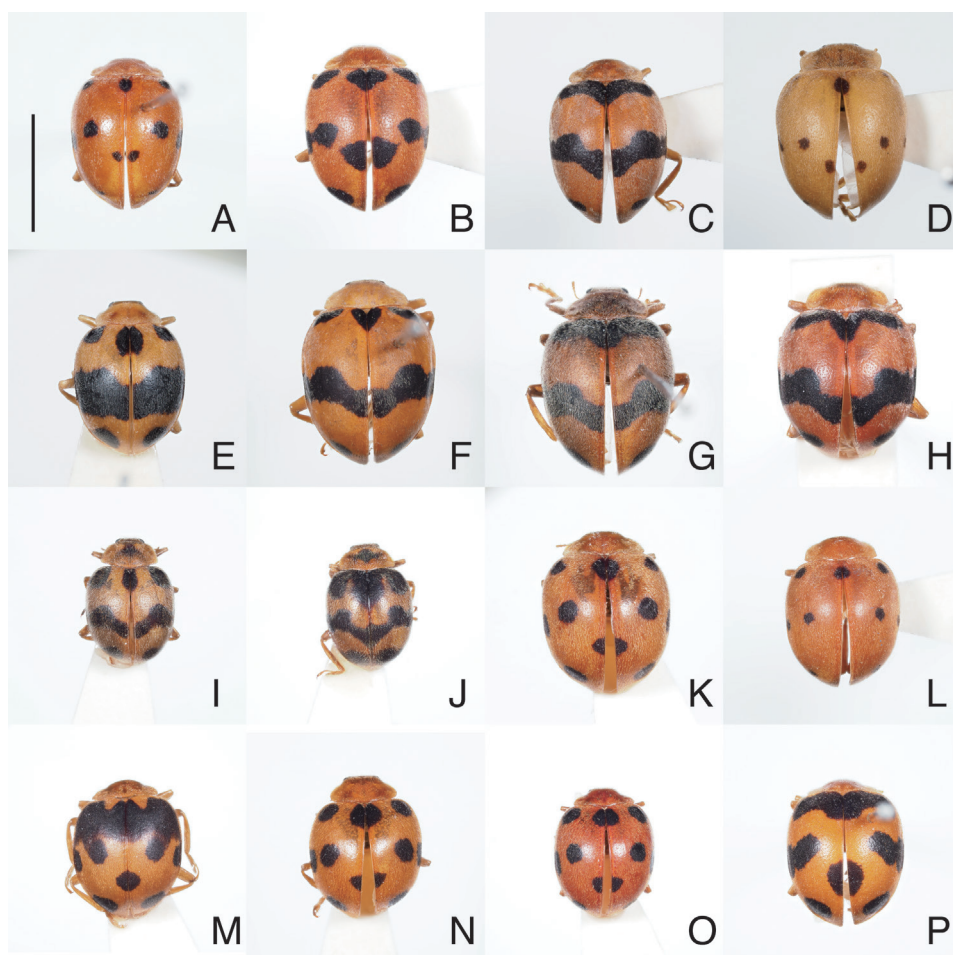


Fig. 2. Habitus. A–G, *Diekeana alternans* (Mulsant): A, Cibodas, West Java (♂); B, Mt. Halimun, West Java (♀); C, Tangkuban Perahu, West Java (♀); D, Danau Telaga Warna, Central Java (♂); E, Mt. Slamet, Central Java (♂); F, near Air Panas Cangar, East Java (♀); G, Cemorokandang, East Java (♀). H, *Diekeana ciremaiensis* Ohta-Matsubayashi & Katakura sp. nov., Mt. Ciremai, West Java (♂, holotype). I, J, *Diekeana isodontis* Ohta-Matsubayashi & Katakura sp. nov., Mt. Patuha, West Java: I (♂, holotype), J (♀). K–M, *Diekeana barisanensis* Ohta-Matsubayashi & Katakura sp. nov.: K, Sukarami, West Sumatra (♂, holotype); L, Mt. Tandikat, West Sumatra (♂); M, Mt. Kerinci, Jambi (♂). N, *Diekeana cyrtandrae* Ohta-Matsubayashi & Katakura sp. nov., Mt. Kerinci (♂, holotype). O, P, *Diekeana gynostemmae* Ohta-Matsubayashi & Katakura sp. nov.; O, Mt. Kerinci, (♂, holotype); P, Mt. Rasam, West Sumatra (♀). Scale bar, 5.7 mm.

rounded; lateral margins arcuate, finely ridged; punctured as head; pubescence dense, fine, and decumbent. Scutellum somewhat narrowly triangular, with pubescence. Elytra broadly rounded at humeral angles, with distinct humeral calli; external borders ridged, narrowly and shallowly channeled except near rounded apex; punctuation mixture of



Fig. 3. Habitus (continued). A, B, *Diekeana rasamensis* Ohta-Matsubayashi & Katakura sp. nov.: A, Mt. Rasam, West Sumatra (♂, holotype); B, Mt. Kerinci, Jambi (♀). C, D, *Diekeana kerinciensis* Ohta-Matsubayashi & Katakura sp. nov., Mt. Kerinci: C (♂, holotype), D (♀). E, *Diekeana concuogensis sumaterautara* Ohta-Matsubayashi & Katakura ssp. nov., Berastagi, North Sumatra (♂, holotype). F, G, *Diekeana concuogensis concuogensis* (Hoang): F, Sapa, north Vietnam (♂), G, Tam Dao, north Vietnam (♀). H, *Diekeana grayi* (Mulsant), Kathmandu, Nepal (♀). Scale bar, 5.7 mm.

two types, with coarser punctures sparsely distributed among much finer and closer punctures; pubescence dense; epipleuron lacking foveae for reception of femora. Underside, prosternal process with lateral carinae (Fig. 1F); mesoventrite punctured, more or less convex along median line; metaventrite fairly coarsely and sparsely punctured; metaventral postcoxal lines joined on metaventral process (Fig. 1G); inner margin of metanepisternum not smooth (Fig. 1I). Mid and hind coxae simple (Fig. 1J); tibiae without oblique carina near apex (Fig. 1K). Tibial spur formula 1-2-2. Tarsal claws long and bifid, without basal tooth. Abdomen with femoral line on abdominal ventrite 1 complete or subcomplete, strongly curved, reaching about one-sixth to two-fifth from the posterior margin of the ventrite (Fig. 1E); abdominal ventrites very closely punctured, with ventrite 5 longer than ventrite 4, truncate behind in male, broadly rounded in female; margin of ventrite 6 emarginate in male (Fig. 1O), entire or notched to a varying degree in female (Figs 1N & 5).

*Male terminalia and genitalia:* Terminalia as in Fig. 1L. Apophysis single, slender. Tegmen (Figs 4, 7–11) well developed; tegminal basal piece without protrusions on inner margin near base of tegminal strut; penis guide (median lobe of tegmen) lacking hairs, in ventral view rather narrow, about six to nine times as long as wide, almost parallel-sided, and distally gradually tapering to pointed apex, seen from lateral side penis guide almost straight or weakly curved ventrally, gradually tapering apically, apex sharply pointed and curved dorsally; parameres (lateral lobes of tegmen) as long as or slightly longer/shorter than penis guide, slender, gently curved near base, distal portion spatulate, and furnished with long and dense hairs; tegminal strut (trabes) robust, short, less than half of penis guide, widened proximally. Penis (Figs 1B–D, 4, 7–11) slender, strongly curved in basal

half, with penis capsule (siphonal capsule) massive but not large and lacking distinct arms, in distal half almost straight and structure like knife blade at distal portion, which bearing edge and basal corner on the ventral side, orifice located apically, obliquely and dorsally, surrounded by cover of short stiff hairs, and distal end covered with “flap” extending from blade edge.

*Female terminalia and genitalia* (Fig. 1M): Tergite X, hind margin shallowly emarginate. Coxites (genital plates) somewhat oval, two times as long as the greatest width; outer margin broadly rounded; interior margin strongly curved into basal margin, widely and shallowly emarginate before tip; styli rather small, with dense, long hairs.

*Diekeana alternans* (Mulsant, 1850)  
(Figs 1E–O, 2A–G, 4A–I, 5A–E, 6)

*Epilachna alternans* Mulsant, 1850: 767 (Type locality: Java); Jadwiszczak and Węgrzynowicz 2003: 34.

*Afissa alternans*: Dieke 1947: 121–122 [partim].

*Afissa grayi*: Dieke 1947: 121.

*Dikeana alternans*: Tomaszewska and Szawaryn 2016: 74 (also see, Szawaryn *et al.* 2015: 562).

*Body* (Fig. 2A–G): Oval to rather elongate oval; moderately convex; pubescence yellowish except on the blackish spots, where it is blackish brown. Size medium to large. Length: ♂ ( $n = 63$ ), 6.7–8.7 mm (syntype, 7.8 mm); ♀ ( $n = 74$ ), 6.5–9.4 mm.

*Maculation*: Pronotum spotless. Elytral pattern variable (Fig. 2A–G): mostly separate but 1-2 and 3-4 often, and 5-3 sometimes coalescing in specimens from mountain regions in Bogor and vicinities in West Java (Mt. Salak, Mt. Gede and Mt. Halimun) (Fig. 2A, B); 1-2 and 5-3-4 always coalescing in mountains around Bandung, West Java (Mt. Tangkuban Perahu and Mt. Patuha) (Fig. 2C); 1-2 often, and 5-3-4 nearly always coalescing in Mt. Bromo and some other sites in East Java (Fig. 2F–G). Spots very small in specimens from Danau Telaga Warna, easternmost part of Central Java (Fig. 2D), and spot 1 and spots 5-3-4 characteristically enlarged in specimens from Mt. Slamet, western part of Central Java (Fig. 2E).

*Male genitalia*: Penis guide (Fig. 4A, B) almost as long as parameres or slightly shorter, in lateral view gradually tapering apically from base, slightly curved ventrally and then moderately curved dorsally near apex. Penis (Fig. 4C) slightly curved dorsally near apex; blade (Fig. 4D–I) short, widest at middle or near tip, dorsal side nearly straight or weakly convex, ventral side strongly convex, sometimes slightly concave near basal corner (Fig. 4G); thorn at basal corner small but acute; neck short, sometimes indistinct (Fig. 4I); edge depth less than half of neck width. Blade Length/Blade Width, 1.6–2.2; Edge Depth/Neck Width, 0.3–0.5; Neck Length/Basal Neck Width, 0.4–1.4; Neck Width/Basal Neck Width, 0.8–0.9.

*Female ventrite 6*: Entire or notched in various degree (Fig. 5A–E).

*Type material examined*: Syntype (♂), Java, Schaum, coll. Haag, *alternans* Mls. typ, *Epilachna alternans* Muls. (by hand) (DEI).

*Other specimens examined* (69♂♂84♀♀: MZB.COLE. 84783–84859; SEHU. 53419–53480, 62401–62413, 62430; all from Java): *West Java (Jawa Barat)* (37♂♂57♀♀): 2♀♀, Halimun, Malasari, 1000m, 9 May 1996 (S. Kahono); 1♂1♀, Mt. Halimun, 3 Oct. 2003 (on *Sechium edule*) (H. Katakura *et al.*); 1♀, Cibodas, 1 Nov. 1990 (on *Cyclanthera brachystachya*) (S. Kahono); 1♀,

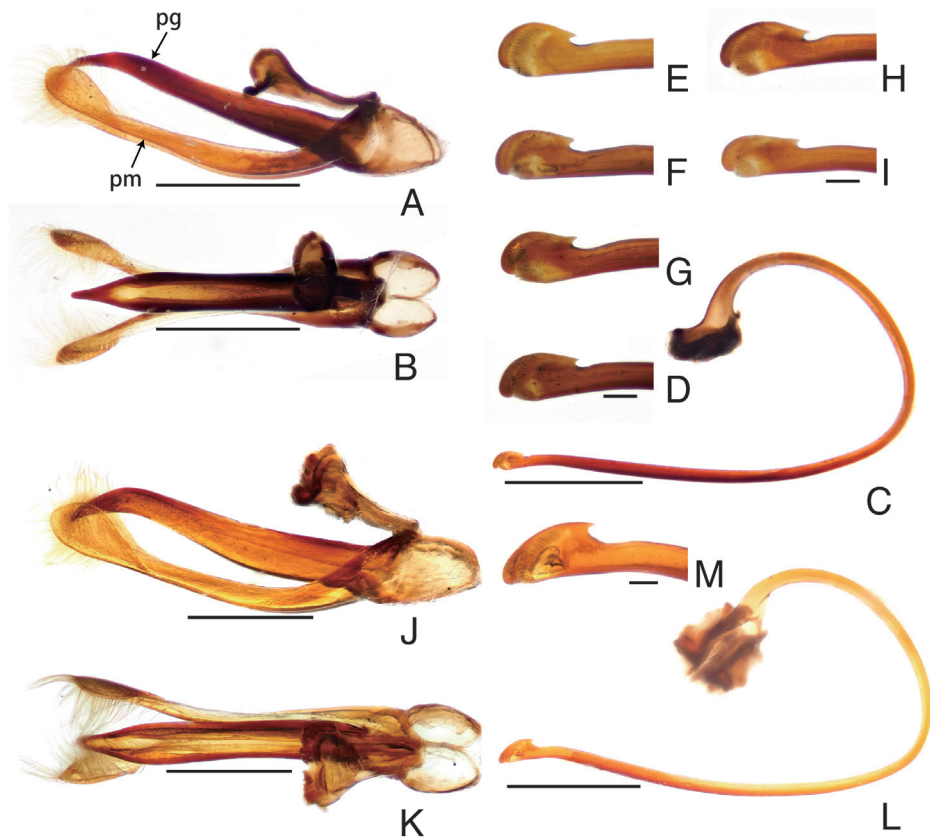


Fig. 4. Male genitalia. A, J, tegmen (lateral view; pg, penis guide; pm, paramere). B, K, tegmen (ventral view). C, L, penis. D–I, M, apex of penis. A–I, *Diekeana alternans*: A–D, Cibodas, West Java; E, Air Panas Cangar, East Java; F, Cemorosewu, East Java; G, Cemorokandang, Central Java; H, I, Mt. Slamet, Central Java. J–M, *Diekeana ciremaiensis*, Mt. Ciremai, West Java. Scale bars: A–C, J–L, 1.0 mm; D–I, M, 0.1 mm.

Cibodas, 28 Nov. 1990 (on *Melothria* sp.) (S. Kahono); 1♂4♀♀, Cibodas, 28–29 Nov. 1990 (on *Melothria* sp.) (H. Katakura & S. Kahono); 3♂♂3♀♀, Mt. Gede, 29 Jan. 1991 (on Cucurbitaceae sp.) (S. Kahono); 1♀, Mt. Gede (1700m), 1 Nov. 1991 (S. Kahono); 1♂1♀, Mt. Gede, near pond, 25 Mar. 1993 (on *Melothria mucronata*) (S. Kahono); 1♂1♀, Mt. Gede, 9 Nov. 1996 (S. Kahono); 1♂1♀, Mt. Gede, 29 Sept. 2003 (H. Katakura *et al.*); 2♂♂1♀, Mt. Gede, 30 Sept. 2003 (on *Sechium edule*) (H. Katakura *et al.*); 2♂♂2♀♀, Mt. Salak, 26 Oct. 1993 (on Cucurbitaceae sp.) (H. Katakura & S. Kahono); 2♀♀, Mt. Salak, 18 Nov. 1994 (1♂1♀ on Cucurbitaceae sp.) (H. Katakura & S. Kahono); 1♂2♀♀, Mt. Salak, 1 Sept. 1996 (on Cucurbitaceae sp.) (S. Nakano); 1♀, Sukamantri, Mt. Salak, 18 Sept. 1996 (S. Kahono); 1♂, Bandung (?), Aug. 1996 (K. Nakamura); 13♂♂17♀♀, Tangkuban Perahu, 10 Feb. 2007 (6♂♂10♀♀ on *Melothria* sp., 7♂♂7♀♀ on *Sechium edule*) (Y. Ohta & S. Kahono); 2♀♀, Mt. Patuha, 9 Feb. 2007 (on *Cyclanthera brachystachya*) (Y. Ohta & S. Kahono); 1♂1♀, Mt. Patuha, 12 June 2008 (on *Cyclanthera*

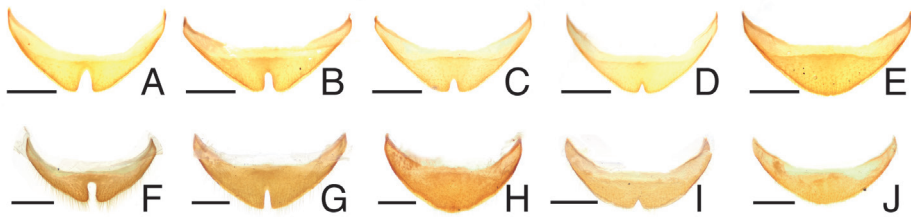


Fig. 5. Ventrite 6 (female). A–E, *Diekeana alternans*, all from Tangkuban Perahu, West Java. F, *Diekeana gynostemmae*, Mt. Kerinci, Jambi, Sumatra. G, H, *Diekeana concuongensis concuongensis*, Tam Dao, north Vietnam. I, J, *Diekeana grayi*, Kathumandu, Nepal. Scale bars: 0.5 mm.

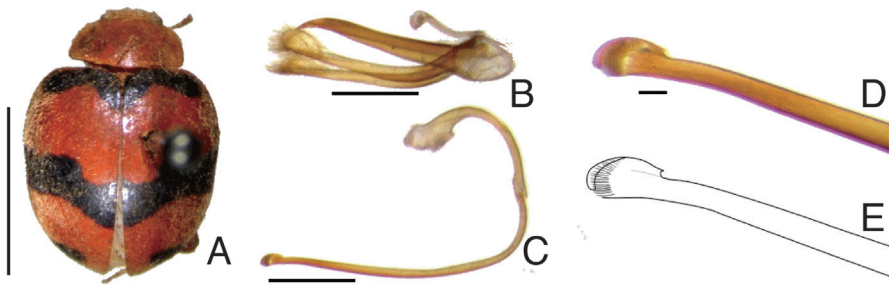


Fig. 6. Syntype of *Epilachna alternans* Mulsant. A, habitus. B, tegmen (lateral view). C, penis. D, E, apical part of penis. Scale bars: A, 5.0 mm; B, C, 1.0 mm; D, 0.1 mm.

*brachystachya*) (H. Katakura *et al.*); 4♂♂7♀♀, Kawar Kamojang, 27 July 2008 (4♂♂3♀♀ on *Melothria* sp.) (K. Matsubayashi). *Central Java (Jawa Tengah)* (9♂♂5♀♀): 4♂♂1♀, Mt. Slamet, Guci, Tegal (2000–2500m), 10 Mar. 2012 (on *Melothria* sp.) (S. Kahono); 2♂♂1♀, Danau Telaga Warna, Dieng, Wonosobo, 15 June 2007 (on *Melothria* sp.) (S. Kahono); 1♀, Telaga Warna, Dieng, Wonosobo (2280m), 15 June 2007 (on *Melothria* sp.) (S. Kahono); 3♂♂2♀♀, Cemorokandang, Tawangmangu, Karanganyar (1765m), 22 Apr. 1998 (on *Melothria mucronata*) (S. Kahono). *East Java (Jawa Timur)* (23♂♂22♀♀): 1♂3♀♀, Cemorsewu, Magetan, (1795m), 22 Apr. 1998 (on *Melothria mucronata*) (S. Kahono); 1♂1♀, Cemorsewu, Magetan, 18 Aug. 2007 (on *Melothria* sp.) (S. Kahono); 1♀, Air Panas Cangar (1450m), 29 Oct. 1994 (H. Katakura); 1♂1♀, Air Panas Cangar (1450m), 29 Oct. 1994 (S. Kahono); 1♀, Air Panas Cangar, Tulungrejo, Batu, Malang, 9 Nov. 2001 (on *Sechium edule*) (H. Katakura); 1♂, Cangar, Batu, 4 Jan. 1994 (S. Nakano); 3♂♂5♀♀, near Air Panas Cangar, Tulungrejo, Batu, Malang, 9 Nov. 2001 (2♂♂4♀♀ on *Trichosanthes* sp.) (H. Katakura & S. Kahono); 16♂♂8♀♀, Mt. Bromo (ca. 2450 m), 10 Nov. 2001 (on *Melothria* sp.) (H. Katakura & S. Kahono); 2♀♀, Wonokiri, Bromo (2540–2550m), 2 Sept. 1995 (S. Nakano).

*Distribution:* Java.

*Host plants:* *Melothria mucronata*, *Sechium edule*, *Trichosanthes ovigera*, *Trichosanthes* spp., *Cyclanthera brachystachya*, other cucurbitaceous plants (Cucurbitaceae: Sicyoeae, Benincaseae) (herbaceous vines).

*Remarks:* Mulsant (1850) described *Diekeana alternans* based on the material

collected in Java, Indonesia, and *Diekeana grayi* based on the specimens from Bengal and North India, as separate species. Although Weise (1923) later synonymized the two species, Dieke (1947) treated them as two distinct species, again, on the basis of obvious difference in the condition of the ventrite 6 of females, that was, according to Dieke, entire in *alternans* whereas deeply notched in *grayi*. However, this interpretation was later proven to be incorrect as discussed later. We also treat *D. alternans* and *D. grayi* as distinct species in this paper, but with reasons different from Dieke. Our interpretation is based on the differences of the morphological detail of penis in male genitalia (compare Fig. 4A–I with Fig. 11) and geographic ranges of the two species (Fig. 14, Table 1).

There is considerable degree of geographic variation in *D. alternans* examined here (Fig. 2A–G), and the specimens from West Java and those from East Java are different in body size and shape, the western specimens being smaller and wider (Fig. 2A–C vs. F, G). The length of blade in the distal part of penis also differs; somewhat longer in the specimens from West Java than those from East Java (Fig. 4D vs. E, F). They may represent different entities worthy to be treated as two allopatric species or two subspecies of a single species. However, our material of *D. alternans* is biased to samples from some localities in West and East Java, and specimens from other localities including Central Java are yet poorly represented. We here treated them as geographic variation within a single species. The type locality of *Diekeana alternans* was described only as “Java” in Mulsant (1850) but the body size and male genital morphology of the syntype examined in this study (Fig. 6A–E) was similar to those of the specimens from West Java, suggesting the type locality to be somewhere in West Java.

Bielawski (1961) figured the genitalia of a syntype specimen of *D. alternans* from Java but he did not mention about the blade in the distal part of penis. Since the blade of *D. alternans* is short, we consider that Bielawski (1961) overlooked this character. The syntype specimen examined by us, which must be the one examined by Bielawski (1961), possessed the blade of the penis as shown in Fig. 6D. With regard to the condition of female ventrite 6, Miyatake (1985) followed Dieke’s view and recorded a Nepalese female with the notched ventrite 6 as *D. grayi*. However, Booth and Pope (1989) pointed out that the interpretation of Dieke was not correct; the paralectotype of *D. grayi* they examined has an entire ventrite 6 while a syntype of *D. alternans* has deeply notched one. Moreover, Katakura *et al.* (2001) reported that the condition of female ventrite 6 was variable even within the specimens of their “*D. alternans*” collected on the same host plant (*Melothria mucronata*) at the same locality (Cibodas in West Java) (this population is now treated as *D. alternans*), from entire through shallowly to deeply notched (also see Fig. 5 for the variation of ventrite 6). Furthermore, Dieke (1947) examined only female specimens for *D. grayi* and *D. alternans* (two females of *D. grayi* from Cibodas in West Java and one female each of *D. alternans* from West Java and Szechuan in China). In the light of our current knowledge, his two females of *D. grayi* and one female of *D. alternans* from West Java were very likely *Diekeana alternans*. On the other hand, one female of *D. alternans* recorded from Szechuan by Dieke was probably due to misidentification because females of the *Diekeana admirabilis* group are very similar in morphology and are often hardly identifiable without associated male specimens.

As described above, *Diekeana alternans* here defined is the species that occurs on cucurbitaceous plants of the tribes Sicyoeae and Benincaseae in Java. Although Katakura *et al.* (2001) recorded *D. alternans* from various localities not only in Java, but also

in Sumatra, the adoption of the name *D. alternans* for those specimens was tentative, actually comprising more than one species of the *D. alternans* complex recognized in the present study.

*Diekeana ciremaiensis* Ohta-Matsubayashi & Katakura sp. nov.  
(Figs 2H, 4J–M)

*Body* (Fig. 2H): Oval; moderately convex; pubescence yellowish except on the blackish spots, where it is blackish brown. Large species. Length: ♂ ( $n = 2$ ), 8.1–8.5 mm (holotype, 8.5 mm); ♀ ( $n = 10$ ), 8.4–9.5 mm.

*Maculation*: Pronotum spotless (holotype) or sometimes with a small, triangular spot before the middle; elytral spots 1-2 and 3-4 always, 5-3 usually coalescing. Spots 1-2 and 5-3-4 coalescing in the holotype (Fig. 2H).

*Male genitalia*: Penis guide (Fig. 4J, K) as long as parameres or slightly shorter, in lateral view tapering apically from middle, weakly curved ventrally and then distal part curved dorsally. Penis (Fig. 4L) moderately curved dorsally near apex; blade (Fig. 4M) short and wide, widest near base; edge convex; basal corner with distinct, sharply pointed thorn; neck indistinct; edge depth slightly smaller than neck width. Blade Length/Blade Width, 2.0; Edge Depth/Neck Width, 0.7; Neck Length/Basal Neck Width, 1.0; Neck Width/Basal Neck Width, 0.9.

*Female ventrite 6*: Entire; somewhat long.

*Type material*: Holotype (♂, MZB.COLE. 84860), Mt. Ciremai (1707m), West Java, 7 Dec. 2006 (H. Katakura *et al.*). Paratypes: (1♂10♀♀: MZB.COLE. 84861–84865; SEHU. 62431–62436), data same with the holotype.

*Distribution*: West Java (thus far known only in Mt. Ciremai).

*Host plants*: *Vernonia* sp. (Asteraceae) (arboreal).

*Etymology*: The specific epithet is originated from the type locality, Mt. Ciremai.

*Diekeana isodontis* Ohta-Matsubayashi & Katakura sp. nov.  
(Figs 2I, J, 7A–D)

*Body* (Fig. 2I, J): Elliptic; moderately convex; pubescence yellowish, even on blackish zone of pronotum, except on the blackish spots on elytra, where it is blackish brown. Small species. Length: ♂ ( $n = 7$ ), 5.4–6.1 mm (holotype, 6.1 mm); ♀ ( $n = 7$ ), 5.2–6.7 mm.

*Maculation*: Pronotum stained obscurely; elytral spots 5-3-4 always, 1-2 often coalescing; holotype, spots 1 and 2 separate (Fig. 2I).

*Male genitalia*: Penis guide (Fig. 7A, B) seen laterally slightly longer than parameres, in lateral view rather narrow, tapering apically from base to middle, and anterior part moderately curved dorsally. Penis (Fig. 7C, D) weakly curved dorsally at apical part, blade very short, almost lacking edge, basal corner nearly right-angled; neck indistinct. Edge depth slightly less than neck width. Blade Length/Blade Width, 1.5; Edge Depth/Neck Width, 0.7; Neck Length/Basal Neck Width, 1.0; Neck Width/Basal Neck Width, 0.8.

*Female ventrite 6*: Entire.

*Type material*: Holotype (♂, MZB.COLE. 84866), Mt. Patuha, West Java, 12 Jun. 2008 (on *Isodon* sp.) (H. Katakura *et al.*). Paratypes (5♂9♀♀: MZB.COLE. 84867–84873; SEHU. 62437–

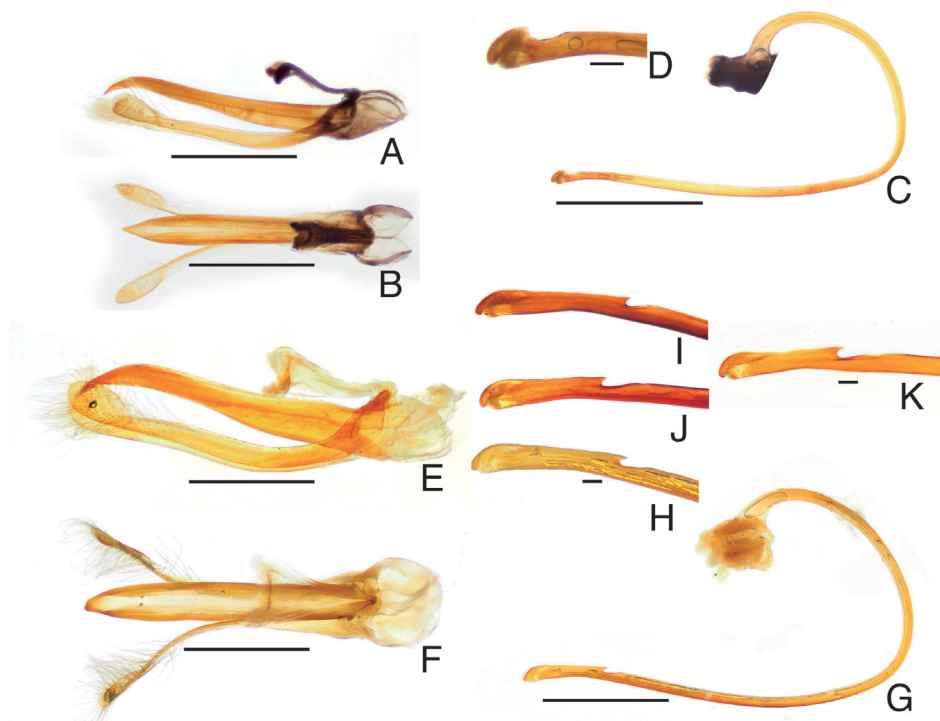


Fig. 7. Male genitalia (continued). A, E, tegmen (lateral view). B, F, tegmen (ventral view). C, G, penis. D, H–K, apex of penis. A–D, *Diekeana isodontis*, Mt. Patuha, West Java. E–K, *Diekeana barisanensis*: E–H, Sukarami, West Sumatra; I, Mt. Tandikat, West Sumatra; J, K, Mt. Kerinci, Jambi, Sumatra. Scale bars: A–C, E–G, 1.0 mm; D, H–K, 0.1 mm.

62443): 1♂8♀♀, Mt. Patuha, data same with the holotype; 4♂♂1♀, Mt. Patuha, West Java, 17 Feb. 2011 (on *Isodon* sp.) (K. Matsubayashi).

*Other specimens examined*: 1♂7♀♀ (MZB.COLE. 84874–84877; SEHU. 62444–62447), Mt. Patuha, West Java, 17 Feb. 2011 (on *Isodon* sp.) (K. Matsubayashi).

*Distribution*: West Java (thus far known only in Mt. Patuha).

*Host plants*: *Isodon* sp. (Lamiaceae) (herbaceous).

*Etymology*: The specific epithet is originated from the genus name of the host plant *Isodon*.

*Diekeana barisanensis* Ohta-Matsubayashi & Katakura sp. nov.  
(Figs 2K–M, 7E–K)

*Body* (2K–M): Oval; moderately convex; pubescence yellowish except on blackish spots, where it is blackish brown. Size medium. Length: ♂ ( $n = 53$ ), 6.5–8.3 mm (holotype, 7.9 mm); ♀ ( $n = 47$ ), 7.1–8.7 mm.

*Maculation*: Pronotum spotless; elytral spots usually medium (Fig. 2K) and 1-2 sometimes coalescing; sometimes anterior part of elytra nearly entirely black in Mt. Kerinci (Fig. 2M), elytral spots small and spots 5 sometimes disappeared in Mt. Tandikat

(Fig. 2L).

*Male genitalia*: Penis guide (Fig. 7E, F) as long as parameres or slightly shorter, in lateral view tapering apically from base, weakly curved ventrally and then apical part moderately curved dorsally. Penis (Fig. 7G) weakly curved dorsally at distal part; blade (Fig. 7H–K) rather long, widest near distal end and narrowest at level about 1/3 to 1/4 from basal corner; thorn at basal corner large; edge slightly and shallowly concave at middle or nearly straight, dorsal side of blade concave; neck distinct, short or medium length; edge depth subequal to or narrower than neck width. Blade Length/Blade Width, 4.5–6.0; Edge Depth/Neck Width, 0.6–0.9; Neck Length/Basal Neck Width, 1.1–2.6; Neck Width/Basal Neck Width, 0.6–0.8.

*Female ventrite 6*: Entire or weakly notched.

*Type material*: Holotype (♂, MZB.COLE. 97001), Sukarami, West Sumatra, Indonesia, 10–12 Nov. 1994 (on *Sechium edule*) (H. Katakura). Paratypes (11♂♂10♀♀: MZB.COLE. 97002–97011; SEHU. 62448–62458): 3♂♂1♀, data same with the holotype; 1♀, Sukarami, West Sumatra, 10 Aug. 1994 (on squash) (S. Nakano); 2♂♂4♀♀, Sukarami, West Sumatra, 27 Jan. 1994 (1♂3♀♀ on squash) (S. Nakano); 5♂♂4♀♀, Sukarami, West Sumatra, 14–15 Nov. 1996 (on *Sechium edule*) (H. Katakura *et al.*); 1♂, Sukarami, West Sumatra, 18 Aug. 1998 (on *Mukia javanica*) (S. Nakano).

*Other specimens examined* (43♂♂38♀♀: MZB.COLE. 97012–97052; SEHU. 62459–62498; all from Sumatra): *Jambi*: 2♀♀, Mt. Kerinci (1840m), 15 Jul. 1986 (on *Trichosanthes* sp.) (I. Abbas); 1♂1♀, Mt. Kerinci (2020m), 15 Jul. 1986 (on *Trichosanthes* sp.) (I. Abbas); 1♂, Mt. Kerinci, 12 Sept. 2001 (on *Trichosanthes* sp.) (S. Nakano); 2♂♂1♀, Mt. Kerinci (ca. 1750–1850m), 5 Nov. 2001 (on *Melothria* sp.) (Asril); 1♂, Mt. Kerinci (1818–2102m), 24 Nov. 2002 (on *Gynostemma*, probably rested) (H. Katakura); 2♂♂2♀♀, Mt. Kerinci (2080–2300m), 20 Feb. 2004 (on *Melothria mucronata*) (S. Kahono & Asril); 1♀, Sungai Penuh, 8 Oct. 2004 (on *Trichosanthes* sp.) (Asril). *West Sumatra (Sumatera Barat)*: 3♂♂3♀♀, Tapan, 25 Nov. 2002 (on *Trichosanthes* sp.) (H. Katakura *et al.*); 1♂1♀, Lake Talang, 14 May 1989 (on *Cucurbita moschata*) (Asril); 1♂, Lake Talang, 2 June 1989 (Asril); 1♂2♀♀, near Lake Talang, 31 Oct. 1993 (H. Katakura *et al.*); 1♀, Solok, 23 Nov. 2002 (on *Sechium edule*) (H. Katakura *et al.*); 1♀, Air Sirah, 2 Dec. 1980 (on *Sechium edule*) (K. Nakamura); 1♀, Air Sirah, 4 Jan. 1981 (on *Sechium edule*) (K. Nakamura); 1♂1♀, Air Sirah, 16 Jan. 1981 (on *Sechium edule*) (K. Nakamura); 2♀♀, Air Sirah, 16 Nov. 1988 (on *Sechium edule*) (S. Nakano); 1♂, Air Sirah, 22 Nov. 1988 (on Cucurbitaceae sp.) (S. Nakano); 1♂1♀, Air Sirah, 8 Nov. 1990 (on *Sechium edule*) (Asril & H. Katakura); 1♀, Air Sirah, 31 Oct. 1993 (H. Katakura); 1♂, Air Sirah, 20 Jan. 1994 (S. Nakano); 1♀, Air Sirah, 26 Nov. 2002 (on *Trichosanthes* sp.) (H. Katakura *et al.*); 1♀, Kayu Aro, 8 Nov. 1990 (on *Sechium edule*) (H. Katakura); 1♂1♀, Lubuk Selasih – Kayu Jao, 12 Oct. 1988 (on *Sechium edule*) (S. Nakano); 1♂, Kayu Jao, 9 Dec. 1988 (on Cucurbitaceae sp.) (S. Nakano); 1♂1♀, Kayu Jao, 18 Dec. 1988 (on Cucurbitaceae sp.) (Zaldi); 2♂♂1♀, Kayu Jao, 3 Feb. 1989 (1♂1♀ on Cucurbitaceae sp.) (S. Nakano); 1♀, Padangpanjang, 15 Jan. 1989 (on *Sechium edule*) (Zaldi); 5♂♂1♀, Mt. Tandikat (1400m), 20 Sept. 1987 (on “Kundur Rinba”) (I. Abbas); 2♂♂2♀♀, Mt. Tandikat, 2 Feb. 2007 (S. Kahono); 15♂♂7♀♀, Mt. Tandikat (1202m), 2 Feb. 2007 (on *Trichosanthes* sp.) (Y. Ohta & S. Kahono).

*Distribution*: Sumatra (West Sumatra, Jambi).

*Host plants*: *Melothria mucronata*, *Sechium edule*, *Trichosanthes ovigera*, *Trichosanthes* spp., *Cucurbita moschata* (Cucurbitaceae: Sicyoeae, Benincaseae, Cucurbitaceae) (herbaceous vines).

*Etymology*: The specific epithet is originated from the Barisan Mountains running north-south along the west side of Sumatra, where this species is distributed.

*Remarks:* This species was treated as a part of *E. alternans* in Katakura *et al.* (2001). There is some geographic difference in the morphological detail of penis (Fig. 7H–K), and the blade tended to be shorter and the neck longer in the specimens from Mt. Kerinci (Fig. 7J, K) in Jambi Province and Tapan in the southernmost part of the province of West Sumatra (Sumatera Barat) than those from the central part of the province of West Sumatra (Padang and the vicinities, Mt. Tandikat, and others; Fig. 7H, I); Mt. Kerinci and Mt. Tandikat are approximately 180 km apart from each other. One male was collected on *Gynostemma* in Mt. Kerinci, but this does not necessary mean that the male was eating *Gynostemma* leaf. Under captivity, *D. barisanensis* did not eat *Gynostemma* leaves (Y. Ohta, unpublished data). Also see Remarks of *D. cyrtandrae* for such occasional stay of the beetles on the plants other than the “legitimate” host plants.

*Diekeana cyrtandrae* Ohta-Matsubayashi & Katakura sp. nov.  
(Figs 2N, 8A–D)

*Body* (Fig. 2N): Oval; moderately convex; pubescence yellowish except on the blackish spots, where it is blackish brown. Size medium. Length: ♂ ( $n = 13$ ), 6.7–7.6

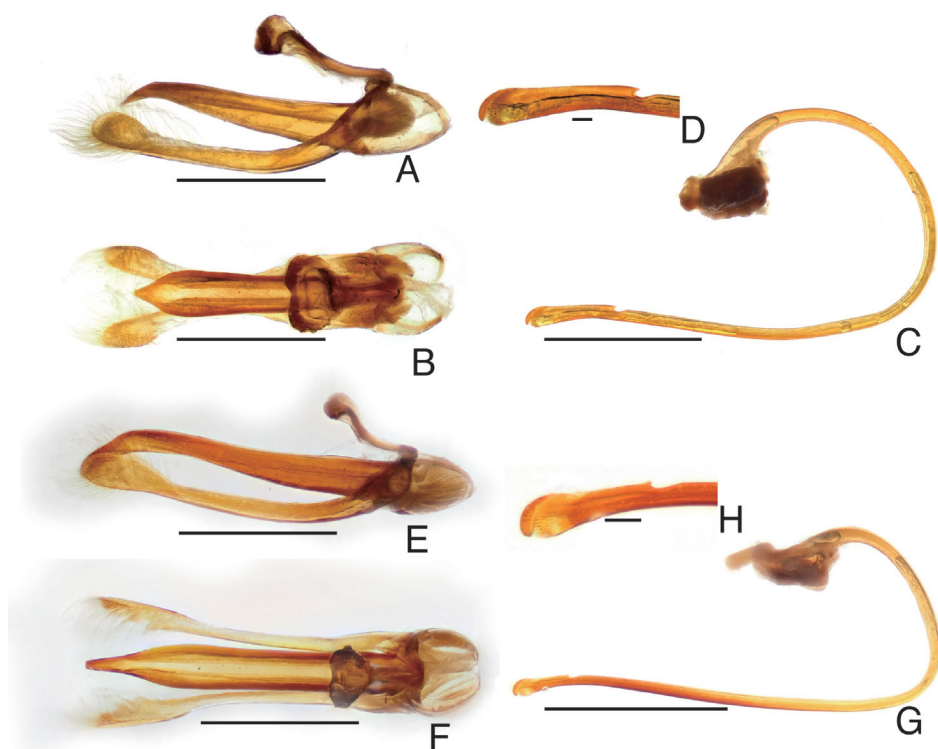


Fig. 8. Male genitalia (continued). A, E, tegmen (lateral view). B, F, tegmen (ventral view). C, G, penis. D, H, apex of penis. A–D, *Diekeana cyrtandrae*, Mt. Kerinci, Jambi, Sumatra. E–H, *Diekeana gynostemmae*, Mt. Kerinci, Jambi, Sumatra. Scale bars: A–C, E–G, 1.0 mm; D, H, 0.1 mm.

mm (holotype, 6.9 m); ♀ ( $n = 6$ ), 7.5–7.8 mm.

*Maculation*: Pronotum spotless; all the elytral spots separate, medium size (Fig. 2N).

*Male genitalia*: Penis guide (Fig. 8A, B) relatively short and thick, slightly shorter than parameres, in lateral view nearly straight, tapering apically from the base, and apical part bent dorsally. Penis (Fig. 8C) very weakly curved dorsally near apex; blade (Fig. 8D) rather long, widest near the apex, dorsal and ventral sides nearly parallel except slightly swollen apical part; thorn at basal corner of medium size; neck distinct, short; edge depth about half neck width. Blade Length/Blade Width, 4.5; Edge Depth/Neck Width, 0.6; Neck Length/Basal Neck Width, 0.8; Neck Width/Basal Neck Width, 0.8.

*Female ventrite 6*: Entire.

*Type material*: Holotype (♂, MZB.COLE. 97053), Mt. Kerinci (1814–2102 m), Jambi, Sumatra, 24 Nov. 2002 (on *Cyrtandra* sp.) (H. Katakura *et al.*). Paratypes (5♂♂5♀♀: MZB.COLE. 97054–97058; SEHU. 62499–62503): 2♂♂5♀♀, data same with the holotype except one male that was found on a *Gynostemma* leaf (probably rested); 2♂♂, Mt. Kerinci (1995 m), Jambi, Sumatra, 18 Nov. 1999 (on *Cyrtandra* sp.) (S. Nakano); 1♂; Mt. Kerinci, Jambi, Sumatra, 12 Sept. 2001 (on *Cyrtandra* sp.) (S. Nakano).

*Other specimens examined* (8♂♂2♀♀: MZB.COLE. 97059–97063; SEHU. 62504–62508; all from Jambi Province, Sumatra): 1♀, Mt. Kerinci (ca. 1750–1850m), 5 Nov. 2001 (on *Cyrtandra* sp.) (Asril); 2♂♂, Mt. Kerinci (ca. 1750–1850m), 5 Nov. 2001 (on *Cyrtandra* sp.) (Hartini, Woro & Katakura); 2♂♂, Mt. Kerinci (ca. 1750–1850m), 5 Nov. 2001 (on *Gynostemma* sp.; probably rested) (H. Katakura); 3♂♂, Mt. Kerinci (1818–2102m), 24 Nov. 2002 (H. Katakura *et al.*); 1♂1♀, Kerinci, 6 Oct. 2004 (on *Cyrtandra* sp.) (H. Katakura *et al.*).

*Distribution*: Sumatra (Jambi; so far known only in Mt. Kerinci).

*Host plants*: *Cyrtandra* spp. (Gesneriaceae) (herbaceous).

*Etymology*: The specific epithet is originated from the genus name of the host plants *Cyrtandra*.

*Remarks*: This species was confused with *Epilachna alternans* in Katakura *et al.* (2001). Three males were collected on *Gynostemma* in Mt. Kerinci. As this species strictly chose *Cyrtandra* leaves when given choices among several potential host plants of the *D. alternans* complex in Sumatra (Y. Ohta, unpublished data), we considered that the males were just resting on *Gynostemma*. At the sampling sites of Mt. Kerinci, where five species of the *D. alternans* complex sympatrically occur, host plants of the *Diekeana* species were often grown in a close proximity, probably resulting in such occasional stays of the beetles on the host plants of other species.

*Diekeana gynostemmae* Ohta-Matsubayashi & Katakura sp. nov.  
(Figs 2O, P, 5F, 8E–H)

*Body* (Fig. 2O, P): Oval; moderately convex; pubescence yellowish except on the blackish spots, where it is blackish brown. Size medium. Length: ♂ ( $n = 53$ ), 5.8–7.3 mm (holotype, 6.1 mm); ♀, ( $n = 25$ ) 6.1–7.8 mm.

*Maculation*: Pronotum spotless; elytral spots medium (Fig. 2O), 1-2 often (both in Mt. Kerinci and Mt. Rasam), 3-4 sometimes (only in Mt. Rasam) coalescing (Fig. 2P).

*Male genitalia*: Penis guide (Fig. 8E, F) sub-equal or slightly longer than parameres, in lateral view rather slender, tapering apically from base to middle, and apical part gently curved dorsally. Penis (Fig. 8G) weakly curved dorsally near apex; blade (Fig.

8H) medium-length, widest near apex, apically swollen, both ventral and dorsal sides concave; neck short and indistinct; thorn at basal corner small; edge depth ca. 1/2 width of neck width. Blade Length/Blade Width, 3.5; Edge Depth/Neck Width, 0.5; Neck Length/Basal Neck Width, 1.3; Neck Width/Basal Neck Width, 0.8.

*Female ventrite 6*: Deeply notched, not wedgewise but rather rectangularly (Fig. 5F).

*Type material*: Holotype (♂, MZB.COLE. 97064), Mt. Kerinci (1814–2102 m), Jambi, Sumatra, 24 Nov. 2002 (on *Gynostemma* sp.) (H. Katakura). Paratypes (17♂♂7♀♀: MZB.COLE. 97065–97076; SEHU. 62509–62520), data same with the holotype.

*Other specimens examined* (35♂♂24♀♀: MZB.COLE. 97077–97105; SEHU. 62521–62550; all from Sumatra): *Jambi*: 2♂♂2♀♀, Mt. Kerinci (1818–2102m), 24 Nov. 2002 (H. Katakura); 4♀♀, Mt. Kerinci (ca. 1750–1850m), 5 Nov. 2001 (on *Gynostemma* sp.) (J. Kojima); 2♂♂1♀, Mt. Kerinci (ca. 1750–1850m), 5 Nov. 2001 (on *Gynostemma* sp.) (Asril); 2♂♂4♀♀, Mt. Kerinci (ca. 1750–1850m), 5 Nov. 2001 (on *Gynostemma* sp.) (H. Katakura); 2♂♂1♀, Mt. Kerinci, 12 Sep. 2001 (on *Gynostemma* sp.) (Asril); 2♂♂2♀♀, Sungai Penuh, 31 Jan. 2007 (on *Gynostemma* sp.) (Y. Ohta & S. Kahono). *West Sumatra (Sumatera Barat)*: 1♂3♀♀, Mt. Rasam, 15 Nov. 1990 (on *Gynostemma* sp.) (Asril & H. Katakura); 15♂♂1♀, Mt. Rasam (1700–1800m), 19 Mar. 1989 (on *Gynostemma* sp.) (Asril & S. Nakano); 1♂1♀, Mt. Rasam (1700–1800m), 19 Mar. 1989 (female on *Gynostemma* sp.) (Zahldi); 2♂♂1♀, Mt. Rasam, 19 Jul. 1989 (on *Gynostemma* sp.) (S. Nakano); 1♂1♀, Mt. Rasam, 19 Jul. 1989 (on *Gynostemma* sp.) (Asril); 3♂♂, Mt. Rasam, 7 Nov. 2001 (on *Gynostemma* sp.) (H. Katakura); 1♀, Mt. Rasam, 6 Feb. 1994 (on *Gynostemma* sp.) (S. Nakano); 1♀, Air Sirah, 13 Nov. 1990 (on *Gynostemma* sp.) (H. Katakura); 1♀, Kayu Jao, 25 Sept. 1988 (on *Gynostemma* sp.) (S. Nakano); 1♂, Sukarami, 10–12 Nov. 1994 (on *Sechium edule*, probably rested) (H. Katakura). *North Sumatra (Sumatera Utara)*: 1♂, Berastagi, 25 Jan. 2007 (on *Gynostemma* sp.) (Y. Ohta & S. Kahono).

*Distribution*: Sumatra (North Sumatra, West Sumatra, Jambi).

*Host plants*: *Gynostemma pentaphyllum* (Cucurbitaceae: Gomphogyneae) (herbaceous vine).

*Etymology*: The specific epithet is derived from the genus name of the host plant *Gynostemma*.

*Remarks*: This species is the only species in which the female ventrite 6 is always deeply notched. It was tentatively treated as a part of “*E. alternans*” in Katakura *et al.* (2001). As listed above, one male was collected on *Sechium edule* at Sukarami, together with *D. barisanensis*. Since this species strictly chose *Gynostemma* leaves when given choices among several potential host plants of the *D. alternans* complex in Sumatra (Y. Ohta, unpubl. data), we considered that the male was just resting on *Sechium edule*.

*Diekeana rasamensis* Ohta-Matsubayashi & Katakura sp. nov.  
(Figs 3A, B, 9A–D)

*Body* (Fig. 3A, B): Oval; moderately convex; pubescence yellowish except on the blackish spots, where it is blackish brown. Size medium. Length: ♂ ( $n = 8$ ), 6.7–7.8 mm (holotype, 7.8 m); ♀ ( $n = 7$ ), 6.8–7.9 mm.

*Maculation*: Pronotum spotless; elytral spots medium, 1 and 5 rather triangular, 3-4 often coalescing in Mt. Rasam (Fig. 3A); anterior part of elytra often nearly entirely black in Mt. Kerinci (Fig. 3B).

*Male genitalia*: Penis guide (Fig. 9A, B) almost as long as parameres or slightly

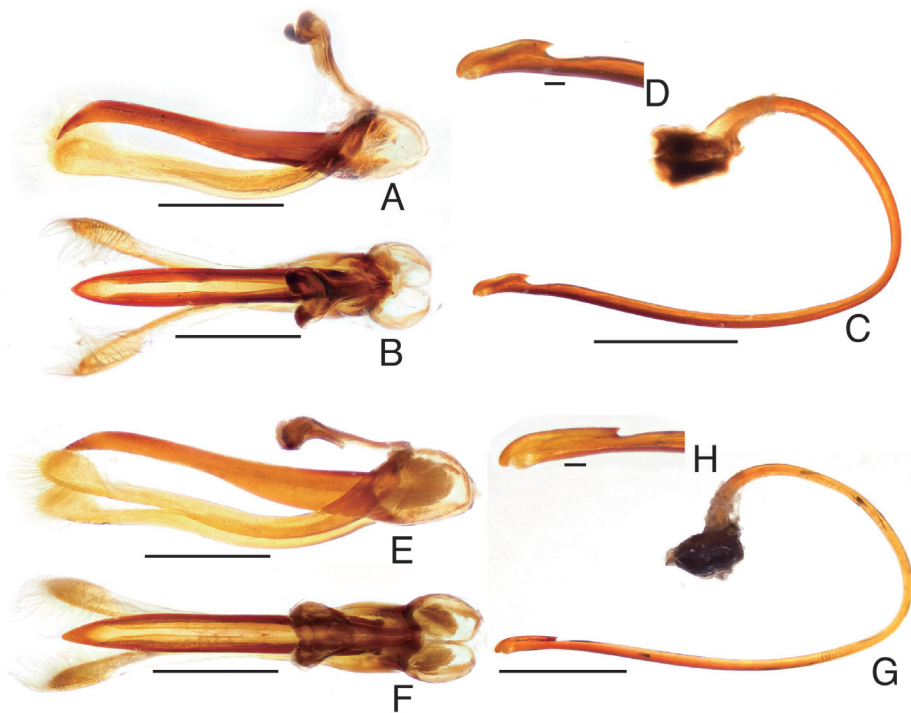


Fig. 9. Male genitalia (continued). A, E, tegmen (lateral view). B, F, tegmen (ventral view). C, G, penis. D, H, apex of penis. A–D, *Diekeana rasamensis*, Mt. Rasam, West Sumatra. E–H, *Diekeana kerinciensis*, Mt. Kerinci, West Sumatra. Scale bars: A–C, E–G, 1.0 mm; D, H, 0.1 mm.

shorter, in lateral view slender, tapering apically from base, and apical part moderately curved dorsally. Penis (Fig. 9C), mildly curved dorsally near apex; blade (Fig. 9D) medium-length, gradually widen toward base, widest near base; edge well developed; thorn at basal corner large and sharply pointed; neck distinct, long; edge depth subequal to neck width. Blade Length/Blade Width, 3.0; Edge Depth/Neck Width, 0.9; Neck Length/Basal Neck Width, 2.0; Neck Width/Basal Neck Width, 0.7.

*Female ventrite 6*: Entire.

*Type material*: Holotype (♂, MZB.COLE. 97106): Mt. Rasam, West Sumatra, 19 Jul. 1989 (on Vernonieae sp.) (Asril). Paratypes (4♂♂4♀♀, MZB.COLE. 97107–97110; SEHU. 62551–62554): 3♂♂2♀♀, data same with the holotype; 1♀, Mt. Rasam, West Sumatra, 7 Nov. 2001 (on Vernonieae sp.) (Sih Kahono); 1♂1♀, Mt. Rasam, West Sumatra, 15 Nov. 1990 (on Vernonieae sp.) (Asril & Katakura).

*Other specimens examined* (4♂♂3♀♀: MZB.COLE. 97111–97113; SEHU. 62555–62558): 1♂, Mt. Rasam, West Sumatra, 30 Aug. 2003 (on Vernonieae sp.) (S. Nakano); 3♂♂3♀♀, Mt. Kerinci (1814–2102 m), Jambi, Sumatra, 24 Nov. 2002 (on Vernonieae sp.) (Katakura *et al.*).

*Distribution*: Sumatra (West Sumatra, Jambi).

*Host plants*: Vernonieae sp. (Asteraceae) (herbaceous vine).

*Etymology*: The specific epithet is originated from the type locality, Mt. Rasam, where this species was first recorded.

*Remarks*: This species was recorded as “*Epilachna* sp. I” in Katakura *et al.* (2001). The environment of Mt. Rasam, where this species was found for the first time, changed into crop fields by 2007 and now this species might be extinct there. Later on, we found this species only in Mt. Kerinci. The host plant was very close to *Decaneuropsis* plants belonging to the tribe Vernonieae of the family Asteraceae based on the homology search of partial sequence of 5.8S rRNA and ITS2 regions of the nuclear DNA (see Appendix). Although *Decaneuropsis* plants are known as scandent shrubs distributed in Southeast Asia (Robinson & Skvarla 2007), we here remain undecided about the generic identity of this plant because of the lack of information on the reproductive characters.

*Diekeana kerinciensis* Ohta-Matsubayashi & Katakura sp. nov.  
(Figs 3C, D, 9E–H)

*Body* (Fig. 3C, D): Short oval; moderately convex; pubescence yellowish except on the blackish spots, where it is blackish brown. Size relatively large. Length: ♂ ( $n = 6$ ), 7.9–8.2 mm (holotype, 8.2 mm); ♀ ( $n = 5$ ), 8.2–8.6 mm.

*Maculation*: Pronotum spotless; elytral spots medium (Fig. 3C); anterior part of elytra sometime nearly entirely black (Fig. 3D).

*Male genitalia*: Penis guide (Fig. 9E, F) as long as parameres or slightly shorter, in lateral view rather slender, tapering apically from base to middle, and apical part moderately curved dorsally to form pointed apex. Penis (Fig. 9G) slightly curved dorsally near apex; blade (Fig. 9H) medium-length, widest near apex, edge well developed; thorn at basal corner of medium size; neck distinct, short; edge depth more than 1/2 width of neck. Blade Length/Blade Width, 4.3; Edge Depth/Neck Width, 0.7; Neck Length/Basal Neck Width, 3.0; Neck Width/Basal Neck Width, 0.7.

*Female ventrite 6*: Entire.

*Type material*: Holotype: (♂, MZB.COLE. 97114), Mt. Kerinci (1814–2102 m), Jambi, Sumatra, 24 Nov. 2002 (on Senecioneae sp.) (Katakura *et al.*). Paratypes (3♂♂3♀♀: MZB.COLE. 97115–97117; SEHU. 62559–62561), data same with the holotype.

*Other specimens examined* (3♂♂3♀♀: MZB.COLE. 97118–97120; SEHU. 62562–62564; all from Jambi Province, Sumatra): 2♂♂1♀, Mt. Kerinci, 12 Sept. 2001 (on Senecioneae sp.) (S. Nakano & Asril); 1♂, Mt. Kerinci, 20 Feb. 2004 (S. Kahono & Asril); 2♀♀, Mt. Kerinci, 18 Nov. 1999 (on Senecioneae sp.) (S. Nakano & Asril).

*Distribution*: Sumatra (Jambi; known only in Mt. Kerinci).

*Host plants*: Senecioneae sp. (Asteraceae) (herbaceous vine).

*Etymology*: The specific epithet is originated from the type locality, Mt. Kerinci, the highest peak of the Barisan Mountains.

*Remarks*: The host plant, whose flower was unknown to us, was suggested to be very close to the genus *Mikaniopsis* in the tribe Senecioneae of the family Asteraceae based on the homology search of partial sequence of 5.8S rRNA and ITS2 regions of the nuclear DNA (see Appendix). However, *Mikaniopsis* is known as native to Africa (cf. Tropicos.org. Missouri Botanical Garden, 21 Jul. 2017 <<http://www.tropicos.org/Name/40019737>>). We postulate that the host plant might be a member of the essentially Asian genus *Cissampelopsis*, a relative of *Mikaniopsis* (Vanijajiva & Kadereit 2008). At a glance, the shape of the blade of the host plant of *D. kerinciensis* (Fig. S1, C, D)

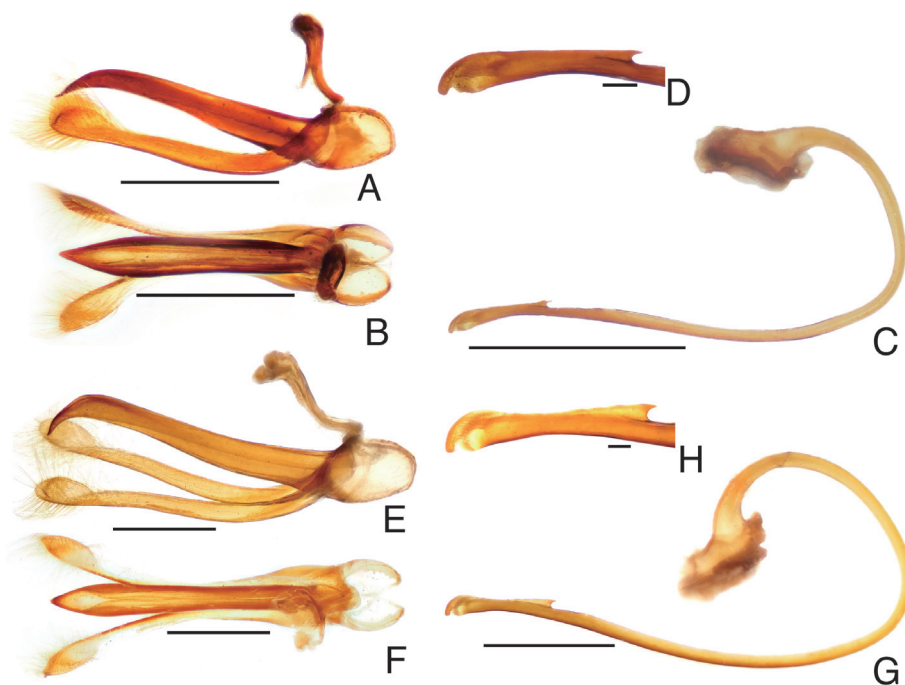


Fig. 10. Male genitalia (continued). A, E, tegmen (lateral view). B, F, tegmen (ventral view). C, G, penis. D, H, apex of penis. A–D, *Diekeana concuongensis sumaterautara*, Berastagi, North Sumatra. E–H, *Diekeana concuongensis concuongensis*, Tam Dao, north Vietnam. Scale bars: A–C, E–G, 1.0 mm; D, H, 0.1 mm.

was similar to that of *Cissampelopsis* species (Vanijajiva & Kadereit 2008). However, we remain undecided about the generic identity of the host plant because we have no information on the reproductive characters.

*Diekeana concuongensis concuongensis* (Hoang, 1978) comb. nov.  
(Figs 3F, G, 5G, H, 10E–H)

*Epilachna concuongensis* Hoang, 1978: 837 (Type locality: Vietnam: Nge Tin', Con Cuong);  
Jadwiszczak and Węgrzynowicz 2003: 51.

*Body* (Fig. 3F, G): Very humped; pubescence grayish even on the blackish maculation. Size medium to large. Length: ♂ ( $n = 17$ ), 6.8–9.1 mm; ♀ ( $n = 19$ ), 7.1–9.6 mm.

*Maculation*: Pronotum spotless or with a small triangular spot before the middle; elytral spots large, 1-2 and 5-3-4 usually coalescing (Fig. 3F, G).

*Male genitalia*: Penis guide (Fig. 10E, F) as long as parameres or slightly shorter, in lateral view mildly tapering from base to middle, weakly curved ventrally and then

apical part sharply curved dorsally to form pointed apex. Penis (Fig. 10G, H), slightly curved dorsally near apex; blade long, widest near distal and basal ends, narrowest at middle, both ventral and dorsal sides concave; thorn at basal corner large and sharply pointed; neck distinct, long, but not so narrow; edge depth ca. 3/4 neck width. Blade Length/Blade Width, 6.1; Edge Depth/Neck Width, 0.8; Neck Length/Basal Neck Width, 2.2; Neck Width/Basal Neck Width, 0.8.

*Female ventrite 6*: Entire or notched (Fig. 5G, H).

*Specimens examined* (17♂♂19♀♀: SEHU. 62565–62600; all from north Vietnam): 2♀♀, Sapa (1663m), 31 Aug. 2005 (on Cucurbitaceae sp.) (H. Katakura *et al.*); 3♂♂1♀, Sapa (1676m), 13 June 2009 (on *Trichosanthes* sp.) (H. Katakura *et al.*); 3♂♂6♀♀, Tam Dao (981m), 2 Sept. 2005 (on Cucurbitaceae sp.) (H. Katakura *et al.*); 5♂♂1♀, Tam Dao (986m), 3 Sept. 2005 (on *Sechium edule*) (H. Katakura *et al.*); 1♂2♀♀, Tam Dao (1266m), 16 June 2009 (on *Sechium edule*) (H. Katakura *et al.*); 1♀, Tam Dao (1089m), 17 June 2009 (H. Katakura *et al.*); 2♂♂1♀, Tam Dao (1266m), 17 June 2009 (on *Sechium edule*) (H. Katakura *et al.*); 2♀♀, Ba Vi (810m), 19 June 2009 (on Cucurbitaceae sp.) (H. Katakura *et al.*), 1♂, Ba Vi (580m), 20 June 2009 (on Cucurbitaceae sp.) (H. Katakura *et al.*); 3♂♂4♀♀, Ba Vi (676m), 21 June 2009 (on or near Cucurbitaceae sp.) (H. Katakura *et al.*).

*Distribution*: North Vietnam.

*Host plants*: *Sechium edule*, *Trichosanthes* sp. (Cucurbitaceae: Sicyoeae) (herbaceous vines).

*Remarks*: The specimens examined are different from the original description of the type specimens (type locality is Con Cuong, approximately 280 km south of Tam Dao where some specimens used in the present study were collected) in Hoang (1978) in elytral maculation. According to the original description, the type specimen has black elytron with two large brown spots and a brown apical part. Size is similar to the specimens from Ba Vi in the present study. However, given very similar male genitalia and the humped body shape, it is likely that the difference in elytral maculation is geographic or individual variation within a single species. Hoang's specimen would be an individual with the elytral black spots very enlarged, so that brown parts of each elytron appeared as described by him.

*Diekeana concuongensis sumaterautara* Ohta-Matsubayashi & Katakura, subsp. nov.  
(Figs 3E, 10A–D)

*Body* (Fig. 3E): Oval; moderately convex; pubescence yellowish except on the blackish spots, where it is blackish brown. Size medium. Length: ♂ ( $n = 7$ ), 6.2–7.1 mm (holotype, 6.7 mm); ♀ ( $n = 11$ ), 6.9–7.8 mm.

*Maculation*: Pronotum spotless; elytral spots separate, medium (Fig. 3E).

*Male genitalia*: Penis guide (Fig. 10A, B) similar to *D. barisanensis*. Penis (Fig. 10C, D) similar to *D. concuongensis concuongensis* but thorn at basal corner slightly less developed and neck longer. Blade Length/Blade Width, 6.3; Edge Depth/Neck Width, 0.9; Neck Length/Basal Neck Width, 4.7; Neck Width/Basal Neck Width, 0.7.

*Female ventrite 6*: Entire.

*Type material*: Holotype (♂, MZB.COLE. 97121), Berastagi (03°14'43.0"N, 98° 32' 02.6"E, 1266 m), Kab. Karo, North Sumatra, 14 Nov. 2011 (on *Sechium edule*) (Katakura *et al.*). Paratypes (4♂♂5♀♀, MZB.COLE. 97122–97125; SEHU. 62601–62605), data same with the holotype.

*Other specimens examined* (2♂♂6♀♀: MZB.COLE. 97126–97129; SEHU. 62606–62609;

all from North Sumatra (Sumatera Utara): 3♀, Berastagi (1230 m alt.), Kab. Karo, 25 Jan. 2007 (on *Sechium edule*) (S. Kahono & Y. Ohta); 2♂♂3♀, Near Lake Toba (1169m alt.), 13 Nov. 2011 (on Cucurbitaceae sp.) (Katakura *et al.*).

*Distribution*: North Sumatra.

*Host plants*: *Sechium edule* (Cucurbitaceae: Sicyoeae) (herbaceous vine).

*Etymology*: The subspecific epithet means “North Sumatra” in Indonesian language.

*Remarks*: This form was once considered as *D. barisanensis* judging from the external morphology, host plant and locality. The penis guide was also similar to *D. barisanensis*. However, the shape of penis was rather similar to that of *D. concuongensis* in Vietnam, with a long and medially narrow blade part, than to *D. barisanensis*. Furthermore, phylogenetic analyses using some mitochondrial DNA markers (Ohta 2010) showed that this form was not close to externally similar *D. barisanensis* but was very closely related to the Vietnamese form of *D. concuongensis* despite their external dissimilarity; the north Sumatran and the Vietnamese forms were reciprocally monophyletic, and together form a single clade. Because of this sister relationship revealed by the DNA analyses coupled with the similarities in the penial morphology and the host plants, we here described this form as a new subspecies of *D. concuongensis*. Further detailed analyses are required to clarify the relationship of this form with other members of the *D. alternans* complex, in particular morphologically similar *D. barisanensis* and genetically closely related *D. concuongensis*. The detailed results of the DNA analyses will be published elsewhere.

*Diekeana grayi* (Mulsant, 1850) comb. nov.

(Figs 3H, 5I, J, 11A–D, 12)

*Epilachna Grayi* Mulsant, 1850: 774 (Type locality: Bengal)

*Epilachna grayi*: Miyatake 1985: 27–28; Jadwiszczak and Węgrzynowicz 2003: 72; Booth and Pope 1989: 354.

*Afissa grayi*: Kapur, 1958: 313–315.

*Epilachna hopeiana* Miyatake, 1985: 28–30, **syn. nov.**

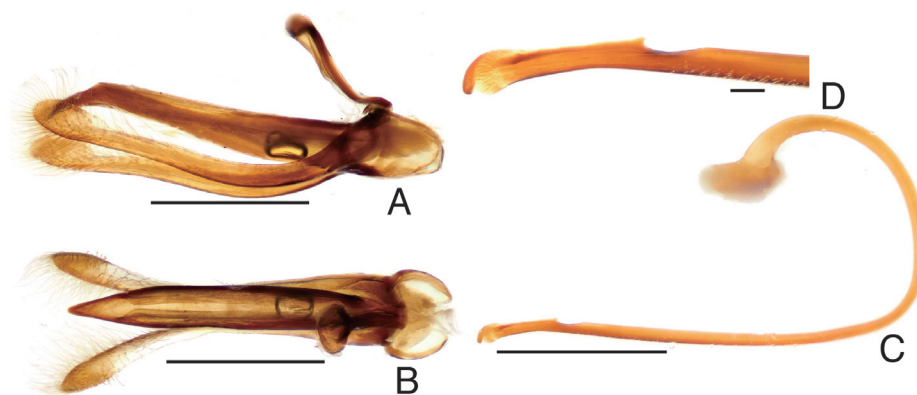


Fig. 11. Male genitalia (continued). *Diekeana grayi*, Kathmandu, Nepal. A, tegmen (lateral view). B, tegmen (ventral view). C, penis. D, apex of penis. Scale bars: A–C, 1.0 mm; D, 0.1 mm.

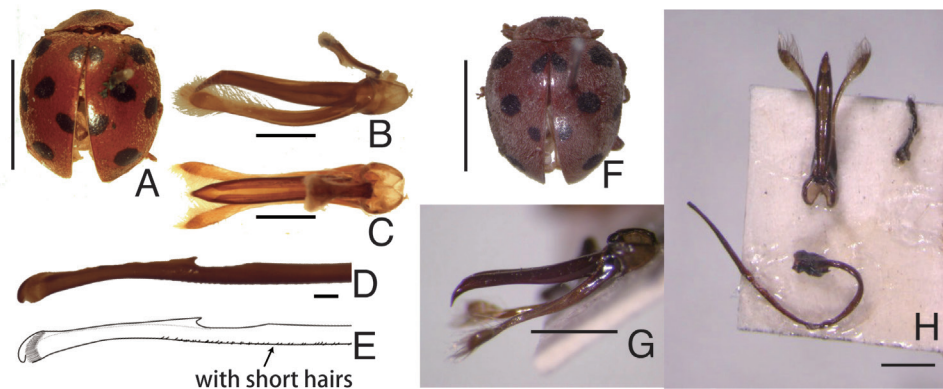


Fig. 12. The lectotype of *Epilachna grayi* Mulsant (A–E) and the holotype of *Epilachna hopeiana* Miyatake (F–H). A, F, habitus. B–E, G, H, genitalia. Scale bars: A, F, 5.0 mm; B, C, G, H, 1.0 mm; D, 0.1 mm.

*Body* (Fig. 3H): Oval; moderately convex, highest at the center of body; pubescence grayish except on the blackish spots, where it is blackish brown. Size medium. Length: ♂ ( $n = 7$ ), 6.9–7.8 mm (lectotype, 7.7 mm); ♀ ( $n = 7$ ), 7.4–8.1 mm.

*Maculation*: Pronotum with a small, triangular or fan-shaped spot before the middle, sometime with lateral crescent spots along the anterior corners; elytral spots separate, medium (Fig. 3H).

*Male genitalia*: Penis guide (Fig. 11A, B) as long as parameres or slightly shorter, in lateral view tapering apically from base, apical part bent dorsally to form pointed apex. Penis (Fig. 11C) slightly curved dorsally near apex; blade (Fig. 11D) long, narrowest at middle, both ventral and dorsal edges concave at middle; thorn at basal corner rather small and sometimes rectangularly angulated; neck distinct but not so narrow, long; dorsal side of neck and adjacent parts equipped with fine short hairs (Fig. 11D, also cf. Fig. 12E); distal end moderately curved ventrally; edge depth ca. 1/2 neck width. Blade Length/Blade Width, 5.1; Edge Depth/Neck Width, 0.5; Neck Length/Basal Neck Width, 2.0; Neck Width/Basal Neck Width, 0.7.

*Female ventrite 6*: Entire or notched (Fig. 5I, J).

*Type material examined*: Lectotype of *E. grayi*: ♂, Bengal, 86 (designated by Booth in Booth and Pope, 1989), Hope Collection, OXUM. Paralectotypes of *E. grayi* (designated by Booth in Booth and Pope, 1989): 1♀, without data; 1♀, innuba Oliv., Hardwicke Bequest, NHML. Holotype of *E. hopeiana*: ♂, Balaju, Kathmandu, 1 Jul. 1968, (T. Kumata), SEHU. Paratypes of *E. hopeiana* (SEHU): 1♀, same data as the holotype; 1♀, Sanupha, No.1 East, 17 Jul. 1968 (T. Matsumura). *E. grayi* in Miyatake (1985): 1♀, Godavari, Nepal Valley, 16 Jun. 1968 (T. Kumata), SEHU.

*Other specimens examined*: 5♂♂2♀♀ (SEHU. 62610–62616), Kathmandu, Nepal, 7–11 Oct. 2005 (on *Sechium edule*) (I. Oshima).

*Distribution*: India, Nepal.

*Host plants*: *Sechium edule* (Cucurbitaceae: Sicyoeae) (herbaceous vine) in Kathmandu; unknown in Bengal.

*Remarks*: As discussed in “Remarks” of *D. alternans*, Dieke (1947) considered that the ventrite 6 of females of *D. grayi* was notched (it was written as “fifth abdominal

segment” in the original text but supposed to be mistaken for “*sixth* abdominal segment”). Miyatake (1985) followed this interpretation. He identified a female Nepalese specimen whose ventrite 6 was notched as *D. grayi* and treated the other two females whose ventrites were entire as a new species *D. hopeiana* (Fig. 12F–H). However, we have found that the paralectotypes of *D. grayi*, designated by Booth in Booth and Pope (1989), have entire ventrites, which does not support the treatment of *D. grayi* and *Epilachna hopeiana* of Miyatake (1985). Furthermore, a DNA analysis (Ohta 2010) showed no genetic difference between a specimen with entire ventrite and another specimen with notched one collected simultaneously on the same host plant (*Sechium edule*) at the same site in Kathmandu, Nepal. Considering this situation and no difference other than the ventrite condition, the specimens treated as *D. grayi* and *E. hopeiana* by Miyatake (1985) very probably belong to a same species.

The establishment of *E. hopeiana* by Miyatake may have been influenced by the fact that the male genitalia of the specimen from Nepal (holotype of *E. hopeiana*) was different from the illustration of *D. grayi* given by Kapur (1958). Kapur (1958) provided figures of the genitalia of a male specimen of *Diekeana grayi* collected in Nepal; the figured penis appeared to lack a blade and a thorn (acute basal corner of the edge) near the apex. However, the lectotype of *D. grayi* has a distinct blade and a hook on the ventral side of penis (Fig. 12A–E), like all other members of the *D. alternans* complex. Furthermore, the dorsal side of the penis of the lectotype was equipped with short hairs (Fig. 12E), the feature being also observed in the holotype of *E. hopeiana* (also cf. Miyatake, 1985, fig. 58) and other Nepalese specimens but not found in other members of the *D. alternans* complex examined in this study. Although the lectotype of *D. grayi* (from Bengal) examined here has a longer blade on the penis than the holotype of *E. hopeiana* or other specimens from Nepal, the difference could be considered to be at an intraspecific variation level, as a considerable degree of variation is observed for the blade length in the single population in Nepal (present study).

Given the situation above, we conclude that *E. hopeiana* is a junior synonym of *D. grayi*.

*Diekeana grayi* and *E. hopeiana* were recorded from various parts of South and Southeast Asia (e.g. Dieke 1947; Pang & Mao 1979; Ren *et al.* 2009). However, these records must be carefully reassessed because there are many other species of the *D. alternans* species complex with similar morphology. As mentioned already the record of this species from Java (Dieke 1947) was probably misidentification. Ren *et al.* (2009: fig. 383) provided pictures of the habitus, tegmen and penis of “*E. hopeiana*.” The spot pattern, the body shape and the penis look different from those of the specimens of *E. hopeiana*, here synonymized with *D. grayi*, but rather similar to *D. concuongensis concuongensis* from Sapa, northern Vietnam, although we cannot determine whether it has short hairs on the outer wall of the penis from the picture by Ren *et al.* (2009). Additionally, Ren *et al.* (2009) listed Guangxi and Vietnam as the distribution ranges of their “*E. hopeiana*”, which suggests the possible confusion of *E. hopeiana* with *D. concuongensis concuongensis*.

#### Other species placed in the *Diekeana alternans* complex

Two additional species are here placed in the *D. alternans* complex based on the literature information.

*Diekeana glochinosa* (Pang & Mao, 1979) comb. nov.

*Epilachna glochinosa* Pang & Mao, 1979: 138–139, pl. XIII (Type locality: Yunnan); Ren *et al.* 2009: 278–279; Pang *et al.* 2012: 12–13.

*Diekeana glochinosa* was described on the basis of one male and two females collected in Yunnan Province in China (Pang & Mao 1979). According to the original description, this species resembles *D. grayi* in general appearance with a blade on the penis of the male genitalia, the character found only in the *D. alternans* complex.

Pictures of the elytral maculation and male genitalia of a specimen identified as this species are presented in Ren *et al.* (2009: fig. 379). The elytra is typically six-spotted and the male genitalia is similar to those of cucurbit-eating species in Sumatra and the continent, namely *D. barisanensis*, *D. concuogensis* and *D. grayi*: the penis has a long blade at the distal portion. In this case, too, it was unable to determine from the picture whether short hairs are present on the dorsal side of penis or not. Pang *et al.* (2012) also listed this species from Hunan and Yunnan with pictures of the external view and male genitalia of a specimen (fig. 9). The elytral spots were large and the body shape appeared rather humped, resembling *E. concuogensis concuogensis* from Sapa, although the specimen was different in the trait of spot 1 being separate from spot 2. The penis appeared to have a longer blade than any specimens we examined in this study, and without short hairs.

According to Pang and Mao (1979), *D. glochinosa* was collected on *Urtica* sp. (Urticaceae) and *Clerodendrum* sp. (Lamiaceae). This fact suggests that *D. glochinosa* is a distinct species, and not conspecific with any cucurbit feeding relatives mentioned above.

*Diekeana bocaki* (Pang & Ślipiński, 2012) comb. nov.

*Epilachna bocaki* Pang & Ślipiński, in Pang *et al.* 2012: 27, 29 (Type locality: Mt. Emei, Sichuan).

Pang and Ślipiński described *Epilachna bocaki* in Pang *et al.* (2012) based on the specimens collected in Sichuan Province in China. They mentioned that this species was very similar to *D. glochinosa*, *D. hopeiana* and *D. concuogensis*, and the diagnostic character was the shape of the penis, with short, clubbed apical piece. The shape of the penis was similar to that of *D. gynostemmae*, but with shorter blade.

SPECIES RELATED TO THE *D. ALTERNANS* COMPLEX

*Diekeana sundaensis* Ohta-Matsubayashi & Katakura sp. nov.  
(Fig. 13A–P)

*Diagnosis*: Essentially similar to the members of the *D. alternans* complex in morphology, but different in that distal part of penis simply swollen and lacking a blade on the inner wall.

*Body* (Fig. 13A): Similar to the *E. alternans* complex in external morphology. Oval; moderately convex; pubescence yellowish except on the blackish spots, where it

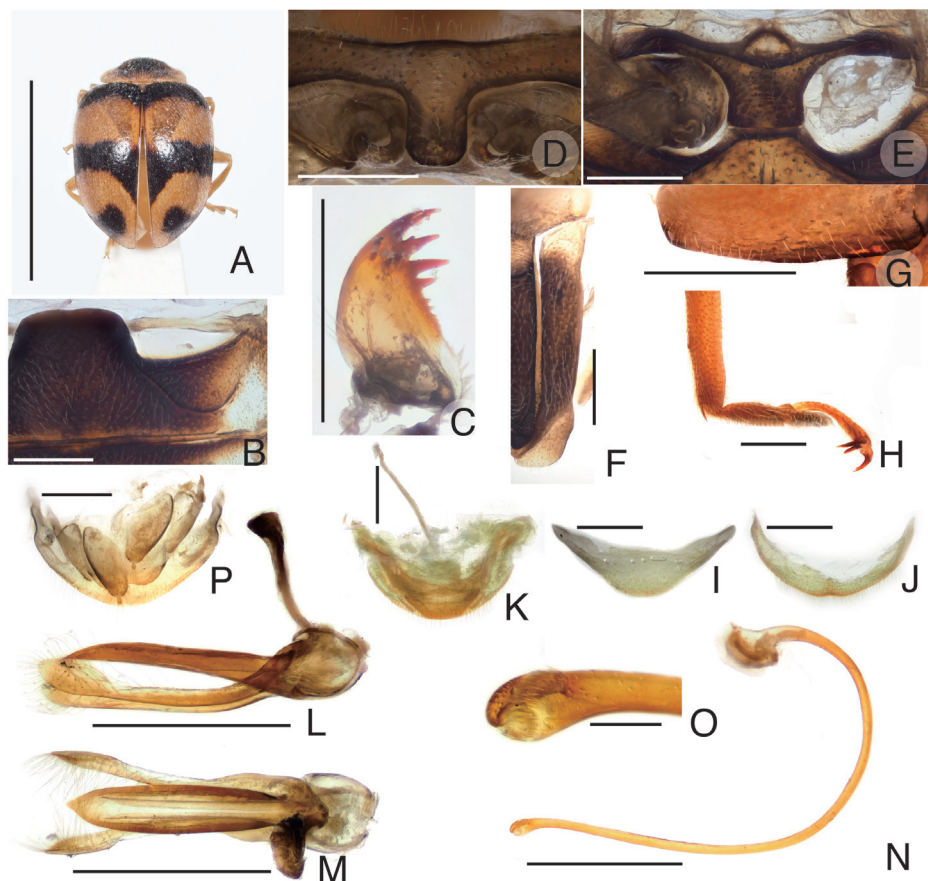


Fig. 13. *Diekeana sundaensis* Ohta-Matsubayashi & Katakura, sp. nov. A, habitus (holotype). B, part of ventrites 1 and 2, showing femoral line. C, mandible. D, prosternal process. E, metaventral postcoxal line. F, metanepisternum. G, posterior part of left hind coxa. H, left hind tibia and tarsus. I, ventrite 6 (female). J, ventrite 6 (male). K, male terminalia. L, tegmen (lateral view). M, tegmen (ventral view). N, penis. O, apex of penis. P, female terminalia and genitalia (part). Scale bars: A, 5.7 mm; B–N, P, 1.0 mm; O, 0.1 mm.

is blackish brown. Size small compared with the members of the *D. alternans* complex. Length: ♂ ( $n = 19$ ), 5.2–6.6 mm (holotype, 5.4 mm), ♀ ( $n = 17$ ), 5.4–6.7 mm.

**Maculation:** Pronotum spotless, with a wide triangular spot, or medio-frontally darker. Elytral spots 1-2 and 3-4 coalescing, often 5-3 also coalescing, forming two transverse fascia as in holotype (Fig. 13A).

Head equipped with finely impressed punctures and dense pubescence; eyes finely faceted; antennae nearly as long as width of head, with three terminal segments forming narrow subserrate club; labrum emarginate in front, with yellowish hairs; mandible (Fig. 13C) multidentate, incisor edge with multiple denticles. Pronotum more than

two times wider than median length, broadly emarginate in front, with anterior corners rectangularly rounded and posterior corners obtusely rounded; lateral margins arcuate, finely ridged; punctured as head; pubescence dense, fine, and decumbent. Scutellum almost equilateral triangle, with pubescence. Elytra broadly rounded at humeral angles, with distinct humeral calli; external borders ridged and narrowly and shallowly channeled except near rounded apex; punctuation mixture of two types, with coarser punctures sparsely interspersed among much finer and closer punctures; pubescence dense; epipleuron lacking foveae for reception of femora. Underside, prosternal process moderately wide, with lateral carinae (Fig. 13D); mesoventrite punctured, more or less convex along median line; metaventrite fairly coarsely and sparsely punctured; metaventral postcoxal lines joined on metaventral process (Fig. 13E); inner margin of metanepisternum not smooth (Fig. 13F). Mid and hind coxae simple (Fig. 13G); tibiae without oblique carina near apex (Fig. 13H). Tibial spur formula 1-2-2. Tarsal claws long and bifid, without basal tooth. Abdomen with femoral lines of abdominal ventrite 1 (Fig. 13B) subcomplete, strongly curved, reaching about one-fourth from the posterior margin of the ventrite; abdominal ventrites very closely punctured, with ventrite 5 longer than ventrite 4, truncate behind in male, broadly rounded in female; margin of ventrite 6 weakly emarginate in male (Fig. 13J) and somewhat rounded in female (Fig. 13I).

*Male terminalia and genitalia:* Terminalia as in Fig. 13K. Apophysis single, slender. Tegmen (Fig. 13L, M) proportionally smaller than the *D. alternans* complex; tegminal basal piece without protrusions on inner margin near base of tegminal strut; penis guide lacking hairs, almost as long as parameres, in ventral view rather broad, about five or six times as long as wide, in lateral view rather narrow, almost straight except apex, with nearly same width except around base and apex, distal part weakly bent dorsally to form pointed apical end; parameres slender, gently curved near base, distal portion spatulate, and furnished with long and dense hairs; tegminal strut (trabes) robust, approximately half length of penis guide, widened proximally. Penis (Fig. 13N) slender and strongly curved in basal half, in distal half almost straight except moderately ventrally curved apex; apex (Fig. 13O) swollen, orifice situated obliquely and dorsally, surrounded by stiff hairs, ventral side of apex covered with a flap leading out of ventral wall, totally lacking blade or its modified structure.

*Female terminalia and genitalia* (Fig. 13P): Similar to the *D. alternans* complex. Tergite X, hind margin emarginate; coxites spindle shape, rather elongate compared to the *D. alternans* complex.

*Type material:* Holotype (♂, MZB.COLE. 97130), Mt. Patuha (07°09'19.2"S, 107° 24' 15.5"E, 2034m), West Java, 8 Dec. 2006 (on *Gynostemma* sp.) (H. Katakura *et al.*). Paratypes (4♂♂5♀♀: MZB.COLE. 97131–97134; SEHU. 62617–62621), data same with the holotype.

*Other specimens examined* (16♂♂15♀♀: MZB.COLE. 97135–97150; SEHU. 62622–62636; all from West Java (Jawa Barat)): 1♂1♀, data same with the holotype; 2♂♂4♀♀, Mt. Patuha (2119m), 8 Dec. 2006 (on *Gynostemma* sp.) (H. Katakura *et al.*); 1♂1♀, Cibodas, 28 Nov. 1990 (H. Katakura & S. Kahono); 2♂♂, Cibulnunggul, Kalapanunggal, 4 Nov. 1994 (on *Gynostemma* sp.) (H. Katakura); 1♂1♀, Mt. Gede, 6 Sept. 1997 (S. Nakano); 1♂1♀, Halimun, 3 Oct. 2003 (on *Gynostemma* sp.) (H. Katakura *et al.*); 1♂, Halimun, 3 Oct. 2003 (K. Matsubayashi); Mt. Ciremai, 2♂♂1♀, 31 Oct. 2008 (Sarino & S. Kahono); 1♂2♀♀, 12 Mar. 2006 (on *Gynostemma* sp.) (Sarino & S. Kahono); Kamojan, 4♂♂4♀♀, 27 Jul. 2008 (on *Gynostemma* sp.) (K. Matsubayashi).

*Distribution:* West Java.

*Host plants:* *Gynostemma pentaphyllum*, *Gynostemma* sp. (Cucurbitaceae:

Gomphogyneae).

*Etymology:* The specific epithet is originated from the Sunda Kingdom located in West Java, where this species occurs.

*Remarks:* *Diekeana sundaensis* was treated as “*Epilachna* sp. F” in Katakura *et al.* (1994, 2001). This species, apparently belonging to the *D. admirabilis* group, is morphologically similar to the members of the *D. alternans* complex, but it is different in that distal part of penis does not have a blade on the inner wall. It seemed to be a specialist on *Gynostemma*, and was particularly abundant in Mt. Patuha, West Java, on *Gynostemma pentaphyllum*. Phylogenetically, *Diekeana sundaensis* is close to the *D. alternans* complex (Ohta 2010). Although specialization to *Gynostemma* is also found in *D. gynostemmae* in West Sumatra, adoption of this particular host plant seemed to occur independently in *D. sundaensis* and *D. gynostemmae*. Externally *D. sundaensis* resembles *D. isodontis* that also occurs in Mt. Patuha.

## DISCUSSION

### *Morphological features*

Morphologically, the *Diekeana alternans* complex is classified into the *Diekeana admirabilis* group defined by Dieke (1947), or “*Epilachna* group 1” defined by Katakura *et al.* (2001). The most important morphological feature that characterizes this complex is the possession of a blade with variable length of edge and variable angle of basal corner at the distal part of penis in male genitalia. It is apparently a synapomorphy of this species complex. Otherwise, the complex shares the following features with other members of the *D. admirabilis* group: the basic elytral pattern with six spots on each elytron, and general structures of male genitalia and female genitalia.

A total of 10 nominal species, one of which comprises two subspecies, were recognized as the members of the *D. alternans* species complex in the present study. They are: *D. alternans*, *D. ciremaiensis*, *D. isodontis*, *D. barisanensis*, *D. cyrtandrae*, *D. gynostemmae*, *D. rasamensis*, *D. kerinciensis*, *D. concuongensis concuongensis*, *D. concuongensis sumaterautara* and *D. grayi*. *Diekeana glochinosa* and *D. bocaki* known from south China was also treated as a member of this species complex based on the literature information. *Diekeana hopeiana* was synonymized with *D. grayi*.

Almost all the taxa treated here are easily identified by the species-specific conditions of the edge and basal corner of the blade of the distal portion of penis. Exceptionally, some *D. barisanensis* has penial characters similar to those of *D. cyrtandrae* because of geographic variation in the former species (compare Fig. 7J and Fig. 8D). However, these two species can be distinguished by another male genitalic character: *D. cyrtandrae* has an obviously shorter and apically sharply-bent penis guide than *D. barisanensis*. We provided a key to the species and subspecies of this complex on the basis of male genitalic characters at the end of this paper.

Other characters are also useful to distinguish between some species. For example, the body size is an important character for *D. alternans* in East Java (large, Fig. 2F, G), some populations of *D. concuongensis concuongensis* (large, Fig. 3G), *D. ciremaiensis* (large, Fig. 2H) and *D. isodontis* (small, Fig. 2I, J). The specific body shapes are also seen in *D. concuongensis concuongensis* (humped back, Fig. 3F, G) and *D. alternans* in East Java (elongate, Fig. 2F, G). The elytral pattern is polymorphic particularly in *D. alternans*, *D. rasamensis*, *D. gynostemmae* and *D. barisanensis*, but is uniform in

*D. grayi* (separate six spots), so there is some degree of interspecific difference (Figs 2, 3). The female ventrite 6 is entire in most species but characteristically notched in *D. gynostemmae* (Fig. 5), which enables to distinguish this species from other Sumatran species. In *D. alternans*, *D. barisanensis*, *D. concuonensis concuonensis* and *D. grayi*, as noted in the remarks of respective species, this character is unstable, and the previous suggestions that the condition of the female ventrite 6 is the diagnostic character among *D. alternans*, *D. grayi* and *D. hopeiana* (Dieke 1947; Miyatake 1985) have turned out to be misinterpretations.

However, the elytral pattern and probably body size are often unreliable as the diagnostic character for the *D. alternans* complex. For example, the elytral pattern and the body shape are often similar among sympatric species (Figs 2, 3): In Mt. Patuha, three sympatric species *D. alternans*, *D. isodontis* and *D. sundaensis* have the coalescing spot pattern and among these, the latter two species are also very similar, being small, in the body size (Fig. 2I, J and Fig. 13A); in Mt. Kerinci, five sympatric species *D. rasamensis*, *D. gynostemmae*, *D. cyrtandrae*, *D. kerinciensis* and *D. barisanensis* have a common appearance with medium-sized separate elytral spots, and three of them share a characteristic coalescent pattern as a infra-population variation (Fig. 2M, Fig. 3B, D). Moreover, elytral pattern may vary considerably among populations of a single species, as demonstrated by *D. alternans* (Fig. 2A–G), *D. barisanensis* (Fig. 2K–M) and other species. *D. c. sumaterautara* is externally not similar to its nominate subspecies, *D. c. concuonensis* at all, but rather similar to sympatric *D. gynostemmae*. Similarity of external morphology in sympatric species is not restricted within the congeneric species: Katakura *et al.* (2001) pointed out the similarity in the elytral pattern and body size between “*Epilachna alternans*” (now *D. barisanensis* and *D. alternans*) and *Henosepilachna pytho* (Mulsant, 1850) sympatrically occurring on cucurbitaceous plants in Sumatra and Java. These situations could be, as Katakura *et al.* (2001) pointed out, examples of Müllerian mimicry, where multiple harmful species not closely related and sharing common predators mimic each other's warning signals.

We have made DNA phylogenetic analyses using some genetic markers for the species and subspecies of the *D. alternans* complex for which DNA samples were available (Ohta 2010). The full account of the results of these analyses will be published elsewhere (Y. Ohta-Matsubayashi *et al.*, in preparation).

#### *Geographic distribution and host plants*

The *D. alternans* complex as a whole has a wide distribution range over South and Southeast Asia, covering southern parts of China, northern parts of Vietnam, Taiwan, India, Nepal, Tibet, Sumatra, and Java (Korschefsky 1933; Dieke 1947; Pang & Mao 1979; Miyatake 1985, the present study) (also cf. Fig. 14). However, old distribution records need to be reevaluated because the members of the *Diekeana admirabilis* group, and hence the members of the *Diekeana alternans* complex, are very similar morphologically, and the patterns of elytral maculation, often used as the diagnostic characters of species, are now known to be variable within a species. The distribution limit of the species complex in the continental Asia is not exactly known. In Indonesia, the species complex is not rare in Java and Sumatra (Fig. 14). Occurrence of this group in Borneo is almost certain since we have examined five female specimens assignable to the *Diekeana alternans* complex, collected in north Borneo (two in Mt. Kinabalu, Saba, and two in Mt. Merinjak and one in Quop, Sarawak) (Hope Collection, OXUM),

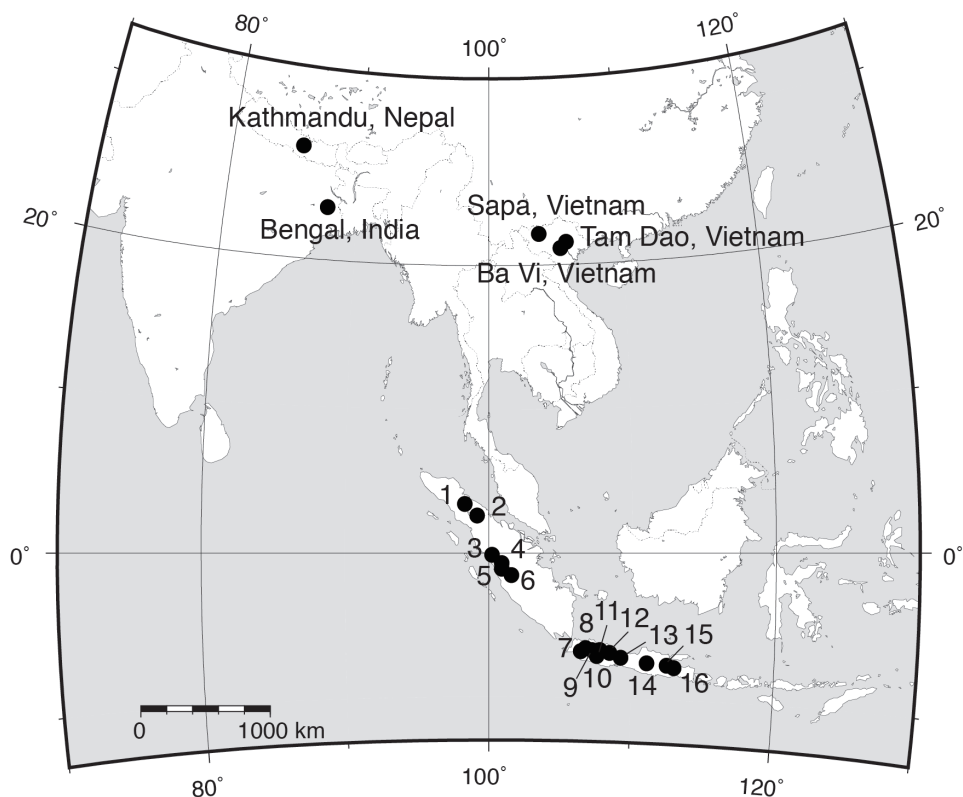


Fig. 14. Major sampling localities of the specimens used in the present study (cf. Table 1). Indonesian localities are shown by the code numbers given in Table 1. Sumatra: 1, Berastagi; 2, Toba; 3, Mt. Tandikat; 4, Sukarami, Solok; 5, Mt. Rasam; 6, Mt. Kerinci. Java: 7, Mt. Halimun; 8, Mt. Salak; 9, Mt. Gede; 10, Mt. Patuha; 11, Mt. Tankuban Perahu; 12, Mt. Ciremai; 13, Mt. Slamet; 14, Cemerosewu; 15, Air Panas Cangar; 16, Mt. Bromo.

although corresponding males were not available. On the other hand, they are thus far not found in Sulawesi, Bali and further east in spite of frequent and intensive surveys made by us. Thus, the eastern limit of the distribution range of the *D. alternans* complex seems Java, implying that this complex is essentially oriental and did not extend their range into Wallacea.

The members of the *D. alternans* complex are characterized by species-specific distribution ranges coupled with particular host plants (Table 1). By this reason, it is rather easy to identify the members of this complex if there is information on the geographic origin and host plants. The species that utilize various species of cucurbitaceous plants in Benincaseae, Sicyoeae and/or Cucurbitae (e.g. *Melothria*, *Sechium*, *Trichosanthes*, *Cucurbita*) as host plants are widespread in South and Southeast Asia, comprising five nominal taxa (*D. grayi*, *D. concuongensis concuongensis*, *D. concuongensis sumaterautara*, *D. barisanensis*, *D. alternans*) (Table 1). The distribution ranges of these species/subspecies do not overlap. In other words, the ranges of the



species that occur on these cucurbitaceous host plants are usually allopatric. On the other hand, the remaining six species are specialized respectively to different taxonomic groups of host plants (*Gynostemma*, *Cyrtandra*, *Senecioneae* sp., *Vernonia*, *Isodon*, *Asteraceae* sp.) and localized in two major islands, Sumatra and Java. In particular in Mt. Kerinci in Sumatra, five species (*D. rasamensis*, *D. gynostemmae*, *D. cyrtandrae*, *D. kerinciensis* and *D. barisanensis*) are strictly sympatric, depending on different host plants. These facts suggest that the common ancestor of the *D. alternans* complex was a feeder of cucurbitaceous plants, and that adaptive radiation to various plants occurred after the ancestor migrated to Sumatra and Java, respectively. Unfortunately, however, it is premature to conclude whether this scenario is valid or not because our knowledge of this group in the Asian continent and Borneo is yet insufficient. Further detailed discussion for the radiation of the *Diekeana alternans* complex in Sumatra and Java will be given elsewhere together with the phylogenetic relationship of the component species based on molecular data (Y. Ohta-Matsubayashi *et al.* in preparation).

KEY TO THE SPECIES AND SUBSPECIES OF THE DIEKEANA ALTERNANS SPECIES COMPLEX BASED  
MAINLY ON MALE GENITALIA

See Fig. 1B–D for the parts of male genitalia. Also see the distribution ranges and host plants of respective species in Table 1.

1. Blade shorter than 2.5 times the maximum width ..... 2
- Blade longer than 2.5 times the maximum width ..... 4
2. Blade very short, almost lacking edge; basal corner nearly right-angled; neck indistinct .....  
..... *D. isodontis*
- Blade short but distinct, basal corner acute ..... 3
3. Blade widest near base, narrowed toward apex; thorn at basal corner small but distinct and  
acute; neck indistinct ..... *D. ciremaiensis*
- Blade widest at middle or near tip, ventrally rounded; thorn at basal corner small but acute;  
neck usually distinct ..... *D. alternans*
4. Blade narrowest near tip, widest near base, with well-developed edge; thorn at basal corner  
large ..... *D. rasamensis*
- Blade narrowest near base, widest near tip ..... 5
- Blade narrowest at middle ..... 7
5. Blade gradually widened apically by degrees. 6
- Distal end of blade swollen roundly; thorn at basal corner small; median lobe sub-equal or  
slightly longer than lateral lobes; anterior part of median lobe gently curved ..... *D. gynostemmae*
6. Penis guide slightly shorter than parameres; apical part of penis guide rather sharply bent .....  
..... *D. cyrtandrae*
- Penis guide sub-equal or slightly longer than parameres; apical part of penis guide gently curved  
..... *D. kerinciensis*
7. Penis with short hairs on dorsal side around neck ..... *D. grayi*
- Penis lacking short hairs on dorsal side ..... 8
8. Blade widest near apex and near base; thorn at basal corner large and sharply pointed .....  
..... *D. concuongensis*
- A. Dorsum of body humped ..... *D. c. concuongensis*
- B. Body shortly oval and moderately convex ..... *D. c. sumaterautara*
- Blade widest near apex; thorn at basal corner large ..... *D. barisanensis*

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APPENDIX. TAXONOMIC IDENTIFICATION OF THE HOST PLANTS OF DIEKEANA SPECIES USING DNA  
HOMOLOGY SEARCH

The host plant of *Diekeana rasamensis* was supposed to be a species of the family Asteraceae but the lower-level taxonomy was not clear. As for the host plant of *Diekeana kerinciensis*, the taxonomic group was not clear at all. We deduced their taxonomic positions by homology search of the DNA sequences.

The samples of the host plants of *D. rasamensis* and *D. kerinciensis* were collected in Mt. Kerinci, Jambi Province, Sumatra, in January 2007. A piece of leaf was put into a small plastic zipper bag with blue silica gel, crashed and dried up.

Total DNA of the plants was extracted from the dried sample by the CTAB method (Murray & Thompson 1980). Sequences containing 5.8S ribosomal RNA (5.8SrRNA) and internal transcribed spacer 2 (ITS2) regions (nuclear DNA) were amplified using the primers named ITS3 and ITS4. Amplification was performed using TaKaRa EX Taq (Takara Bio, Inc., Japan) in a 170-8720JA/170-8722JA iCycler (Bio-Rad Japan, Tokyo) under the following conditions: 95°C for 3 min; 35 cycles of 95°C for 30 sec, 50°C for 90 sec, 72°C for 3 min; and 72°C for 10 min.

The plant sequences were determined by the direct sequencing method. PCR products were purified using the silica method and sequenced with a BigDye Terminator v3.1 Cycle Sequencing Kit (Applied Biosystems, Foster City, CA) and an ABI PRISM 3100-Avant Genetic Analyzer (Applied Biosystems, Inc.).

Highly similar sequences to the plant sequences obtained were searched by the Basic Local Alignment Search Tool (BLAST) (URL: <http://blast.ncbi.nlm.nih.gov/Blast.cgi>; accessed on 19 September 2017). A hundred of similar sequences were obtained and they were aligned by ClustalW. The neighbor-joining trees of the target sequences and those similar sequences were reconstructed by the neighbor-joining method, with the maximum composite likelihood (Tamura *et al.* 2004) by MEGA 6 software (Tamura *et al.* 2013).

The partial sequences of 5.8SrRNA and ITS2 regions were determined for the host plants of *D. rasamensis* and *D. kerinciensis*, and their taxonomic positions were inferred as follows. Three supplementary figures (Figs S1–3) are available online on HUSCAP.

**The host plant of *Diekeana rasamensis* (Fig. S1A, B) (DDBJ/EMBL/GenBank accession number: LC320667)**

All but one of the 100 sequences obtained by BLAST belonged to the tribe Vernonieae (genera *Baccharoides*, *Blanchetia*, *Cabobanthus*, *Critoniopsis*, *Decaneuropsis*, *Eremanthus*, *Ereosis*, *Gymnanthemum*, *Hesperomannia*, *Heterocoma*, *Lessingianthus*, *Lychnophora*, *Lychnophoriopsis*, *Paralychnophora*, *Piptolepis*, *Pleurocarpaea*, *Prestelia*, *Tarlmounia*, and *Vernonia*) of the family Asteraceae. The last one sequence belonged to the genus *Acanthospermum* of the tribe Millerieae. In the NJ tree for the 101 sequences using 385 sites (gaps/missing data treatment—pairwise deletion), the host plant of *D. rasamensis* constituted a cluster with three *Decaneuropsis* sequences (one of which was registered as *Vernonia cumingiana* but is now treated as a synonym of *Decaneuropsis cumingiana*), and *Gymnanthemum* sequences were sister to this cluster. The reconstructed NJ tree for 22 selected sequences using 268 sites (gaps/missing data treatment—complete deletion) (Fig. S2) still demonstrated the monophyly of the host plant of *D. rasamensis* and *Decaneuropsis*. The *Acanthospermum* sequence

appeared among the cluster consisting of *Lychnophora* and *Lychnophoriopsis*.

**The host plant of *Diekeana kerinciensis* (Fig. S1C, D) (DDBJ/EMBL/GenBank accession number: LC320668)**

All the 100 sequences obtained by BLAST belonged to the tribe Senecioneae (genera *Brachyglottis*, *Chersodoma*, *Cremanthodium*, *Cineraria*, *Dendrosenecio*, *Dolichorrhiza*, *Hubertia*, *Humbertacalia*, *Iranecio*, *Lasiocephalus*, *Ligularia*, *Mikaniopsis*, *Oresbia*, *Pladaroxylon*, *Pojarkovia*, *Senecio*, *Stilpnogyne*, and *Synotis*) of the family Asteraceae. In the NJ tree for the 101 sequences using 291 sites (gaps/missing data treatment—complete deletion), the host plant of *D. kerinciensis* was within the cluster containing two *Mikaniopsis* sequences. The reconstructed NJ tree for 20 selected sequences using 307 sites (gaps/missing data treatment—complete deletion) (Fig. S3) still supported that the host plant of *D. kerinciensis* is included in the *Mikaniopsis* cluster.

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