Jour. Trop. Coleop. 3(1), 55-73
JOURNAL OF TROPICAL COLEOPTEROLOGY
ISSN online 2718-9740 ; print 2719-1486

Notes on *Therates alboobliquatus* (Horn, 1909) (Coleoptera: Cicindelidae) from Taiwan and description of two new subspecies

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Abstract

Two new subspecies of *Therates alboobliquatus* (Horn, 1909), *amisi* new subspecies and *fangi* new subspecies are described. An identification key of all subspecies of *alboobliquatus* is given. The subspecies are distinguished by the shape of the midline on the elytra. The distribution of the subspecies corresponds to the regional climatic patterns of Taiwan.

Keywords: Biogeography, new subspecies, *Therates alboobliquatus*, Taiwan.

Introduction

The genus *Therates* Latreille, 1817 contains 124 species (Wiesner 2020: 89), mostly distributed in Southeast Asia. They are relatively small sized tiger beetles with a peculiar ecological niche for the adult that includes terrestrial and semi-arboreal habitats. Adults occur regularly on leaf surfaces of undergrowth forest vegetation and occasionally on the soil surface in cleared areas such as wooded paths. Unlike most tiger beetle larva that construct tunnels in soil, the larvae of *Therates alboobliquatus* dig their tunnels into soft, corky, and rotten wood. Here they capture prey that pass near the tunnel entrance (Lin 2014: 103).
The species *Therates alboobliquatus* has been found throughout Taiwan and the Ryukyu Islands of Japan. Based on different elytral maculation patterns, four subspecies have been described. The nominate *T. alboobliquatus* from Taiwan was originally described as a subspecies of *Therates clavicornis* by Horn (Horn 1909: 186) and was elevated to a species by Nakane (1955: 24). He also established a new subspecies, *T. a. yakushimanus,* collected from Yakushima Is. but also found on Amami-oshima Is., Tokunoshima Is. and Okinawa Is. of Japan (Nakane 1955: 24). Kano (1931: 69) described a new species, *T. kotoshonis*, collected from Lanyu Is., but which was subsequently downgraded to a subspecies of *T. a. kotoshonis* by Miwa (1936: 28, as erroneously spelled *kotoensis*). The subspecies *T. a. iriomotensis* was described by Chujo (1970: 2), and it is distributed on Iriomote Is. and Isigaki Is. of Japan.
Some specimens of *T. alboobliquatus*, collected more recently by the first author in the eastern and southwestern parts of Taiwan are distinct from the other four subspecies of *alboobliquatus*, and described herein.

DOI: https://doi.org./10.53716/jtc.3.1.8.2022
ZOOBANK: https://zoobank.org/References/345DA4D2-7746-43BB-A5CD-8B6737BDFF08
Received: 29 April 2022
Published: 30 July 2022
www.jtcoleop.com

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Materials and methods

A total of 235 specimens were measured for this study of which 225 specimens were collected from 78 localities in Taiwan. Specimens with location data without indication of the collector were collected by the first author.

The measurements (Fig. 1) were taken as following: width of head, across eyes (HW); length of left elytron (EL); maxima width of elytra (EW); width at the midst of humeral spot (HSW); distance between left middle band inner end and suture (D); width at the midst of middle band (MBW); length of left middle band, straight line of central axis (MBL). The Slope of left middle band, namely the ratio of projective length of left middle band (central axis) on y axis and projective length of left middle band on x axis (SMB) and approximated area of elytra (AE = product of EL and EW) were calculated. Moreover, the gender, locality and altitude of specimens are also recorded, and all the measurements of males and females were calculated separately.
Numbers on Fig. 2 refer to locations of the collecting sites indicated in the text as specific localities in bold and brackets.
The materials used were dry pinned specimens and the measurements were taken by a stereomicroscope (WILD MZ8) with a graticuled eyepiece. The color photograph of habitus was taken by a digital camera (Nikon D3300).

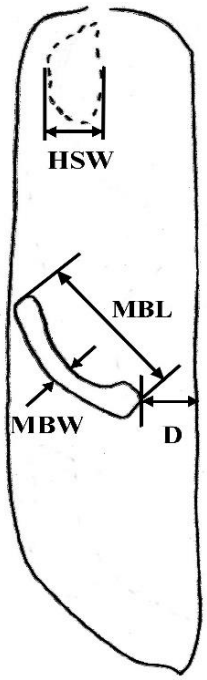

Figure1. Measurement of elytral markings. HSW: Width at the midst of humeral spot; MBL: Length of left middle band, straight line of central axis; MBW: Width at the midst of middle band; D: distance between left middle band inner end and suture.

Studied material

Therates alboobliquatus alboobliquatus (Horn, 1909) (Fig. 3a, 3b, 4a, 4b, 5)

Localities. 21. V. 1997, Kaohsiung City, Taoyuan District, Tengzhi National Forest Recreation Area (N.F.R.A.), 1 ♀ [**1**]; 30. V. 1997, Taichung City, Heping District, Wushikeng Low Altitude Experimental Station (L.A.E.S.), leg. Jen-Zon Ho, 2 ♀ [**2**]; 27. IV. 2002, Kaohsiung City, Liugui District, Neiying Mt. alt. 1170 m, 1 ♂ [**3**]; 1. V. 2002, Nantou County, Yuchi Township, Shuishe Great Mt. trail alt. 1000-1100 m, 5 ♂, 3 ♀ [**4**]; 25. VII. 2002, Yilan County, Datong Township, Mingchi, 1 ♂ [**5**]; 19. V. 2004, Chiayi County, Alishan Township, Lijia, jiaojiaosi trail, 1 ♂ [**6**]; 18. V. 2005, Chiayi County, Alishan Township, Lijia, Sibisibi, 1 ♂ [**7**]; 13. V. 2007, Nantou County, Zhongliao Township, Sijiao Mt. alt. 1150m, 2 ♂, 1 ♀ [**8**]; 18. V. 2008, Taichung City, Heping District, Wushikeng (L.A.E.S.), leg. Jen-Zon Ho, 1 ♀ [**9**]; 25. VI. 2009, Pingtung County, Chunri Township, Jinshuiying trail 1.5 k, 1

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Published: 30 July 2022
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♀ [**10**]; 5. VII. 2009, Miaoli County, Nanzhuang Township, Luchang, Jiali Mt. alt. 1505-1805 m, 3 ♂, 4 ♀ [**11**]; 9. VII. 2011, Miaoli County, Guanwu, Shenmu Forest-road 1 k, leg. Jing-Xun Lin, 1 ♂ [**12**]; 9. VII. 2011, Miaoli County, Guanwu Shenmu Forest-road 2.7 k, 1 ♂ [**13**]; 15. VII. 2014, Hsinchu County, Wufeng Township, Xiakaluo trail alt. 1665 m, 1 ♂ [**14**]; 15. VII. 2014, Hsinchu County, Wufeng Township, Xiakaluo Great Mt. alt. 2322 m, 1 ♂ [**15**]; 3. VIII. 2014, Nantou County, Xinyi Township, Lulin Sacred Tree, 1 ♂ [**16**]; 4. VIII. 2014, Chiayi County, Alishan Township, Tefuye trail 3 k, 1 ♂ [**17**]; 17. VIII. 2014, Taichung City, Heping District, Malun Mt. alt. 2180 m, 1 ♂ [**18**]; 3. V. 2015, Miaoli County, Sanyi Township, Guandao Mt. trail 1.3-1.8 k, 1 ♂, 1 ♀ [**19**]; 7. V. 2015, Nantou County, Lugu Township, Maopu, Jiaolin Forest-road 4.5 k, 1 ♂ [**20**]; 9. V. 2015, Nantou County, Lugu Township, Maopu, Jiaolin Forest-road 3.5 k, 1 ♂ [**21**]; 13. V. 2016, Tainan City, Nanhua District, Sanjiaonan Mt. alt. 1000m, 2 ♂, 2 ♀ [**22**]; 13. V. 2016, Tainan City, Nanhua District, Fanbaojian Mt. E. 1 k, 1 ♀ [**23**]; 19. VI. 2016, Yunlin County, Gukeng Township, Shibi, Shibi Mt. alt. 1640 m, 2 ♂ [**24**]; 19. VI. 2016, Yunlin County, Gukeng Township, Jiananyun Mt. alt. 1500 m, 1 ♂ [**25**]; 19. VI. 2016, Yunlin County, Gukeng Township, Shibi, Lianxin-Pond alt. 1135 m, 1 ♂ [**26**]; 25. VI. 2016, Hsinchu County, Jianshi Township, Lidong Mt., leg. Jing-Xun Lin, 1 ♀ [**27**]; 17. VII. 2016, Miaoli County, Dahu Township, Malabang Mt. alt. 1280-1325 m, 2 ♂, 1 ♀ [**28**]; 5. VIII. 2016, Yilan County, Datong Township, Jialuo Mt. alt. 1860-1925 m, 2 ♂ [**29**]; 5. VIII. 2016, Yilan County, Datong Township, Siji Forest-road alt. 1560 m, 1 ♂ [**30**]; 14. V. 2018, Taichung City, Heping District, Baimao Mt. alt. 1085-1205 m, 3 ♂ [**31**]; 26. V. 2018, Chiayi County, Fanlu Township, Dahujian Mt. alt. 1160 m, 2 ♂ [**32**]; 28. V. 2018, Nantou County, Puli Township, Guandao Mt. alt. 1545-1715 m, 2 ♂, 1 ♀ [**33**]; 4. VIII. 2018, Hsinchu County, Wufeng Township, Egongji Mt. alt. 1350-1579 m, 1 ♂, 2 ♀ [**34**]; 11. V. 2019, Chiayi County, Alishan Township, Lijia, Lijia-Shanmei trail, alt. 915-960 m, 4 ♂ [**35**]; 11. V. 2019, Chiayi County, Alishan Township, Lijia, Duoyang Mt. trail, alt. 1470-1500 m, 2 ♂ [**36**]; 12. V. 2019, Chiayi County, Alishan Township, Lijia, Dingbenzi Mt. trailhead, alt. 1530 m, 1 ♀ [**37**]; 31. V. 2019, Kaohsiung City, Namaxia District, Quji Mt., alt. 970-1340 m, 1 ♂, 1 ♀ [**38**]; 12. VII. 2019, New Taipei City, Sanxia District, Manyueyuan (N.F.R.A.), Dongman trail, alt. 685-815 m, 1 ♂, 1 ♀ [**39**]; 13. VII. 2019, New Taipei City, Wulai District, Badao'er Mt. trail, alt. 990 m, 1 ♂ [**40**]; 14. VII. 2019, New Taipei City, Wulai District, Datong Mt. trail, alt. 780 m, 1 ♂, 1 ♀ [**41**]; 6. VI. 2020, Hsinchu County, Wufeng Township, Bailan, Shitou ecological trail, alt. 1245 m, 2 ♀ [**42**]; 12. VI. 2020, Kaohsiung City, Taoyuan District, Zhongzhiguan trail, alt. 2085 m, 1 ♂, 1 ♀ [**43**]; 2. VIII. 2018, Taitung County, Haiduan Township, Nan Mt., alt. 1580 m, 1 ♂ [**77**]; 28. V. 2021, Pingtung County, Sandimen Township, Weiliao Mt., alt. 1294 m, 1 ♂ [**88**]; 29. V. 2021, Kaohsiung City, Maolin District, Wangzi Mt. route, alt. 1289 m, 1 ♂ [**89**]; 17. VI. 2021, New Taipei City, Pinglin District, Sidu Mt., trail 461 m, 1 ♀ [**90**]; 17. VI. 2021, Yilan County, Toucheng Township, Sidu route, Fengkongzixi Mt., 783 m, 1 ♀ [**91**]; 18. VI. 2021, Yilan County, Nan'ao Township, Lankan Mt., 1445 m, 1 ♂, 1 ♀ [**92**]; 19. VI. 2021, New Taipei City, Shuangxi District, Canguangliao trail, 430 m, 1 ♂ [**93**]; 11. VII. 2021, Taoyuan City, Fuxing Township, Fufu Mt., 1400 m, leg. Jing-Xun Lin, 1 ♂ [**94**]; 13. VI. 1997, Fenchihu, leg. Klapperich, 1 ♀ [**99**]; 30. V. 1997, Fenchihu, leg. Klapperich, 2 ♂ [**100**]; 19-26. V. 1908, Kosempo, leg. Sauter, 1 ♂, 1 ♀ [**101**]; 28. V. 1992, leg. Y. B. Fan, 1 ♂ [**102**]; 4. VIII. 2018, Hsinchu County, Wufeng Township, Egongji Mt., alt. 1350-1579 m, 1 ♂, 1 ♀ [**103**]; 19. V. 1976, Nanshanchi, leg. K. Akiyama, 1 ♂ [**104**]; 5.

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www.jtcoleop.com

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JOURNAL OF TROPICAL COLEOPTEROLOGY
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VII. 2009, Miaoli County, Nanzhuang Township, Luchang, Jialin Mt., alt. 1505-1805 m, 1 ♂, 1 ♀ [**105**]; 1. V. 2002, Nantou County, Yuchi Township, Shuishe Great Mt. trail, alt. 1000-1100 m, 1 ♂, 1 ♀ [**106**].

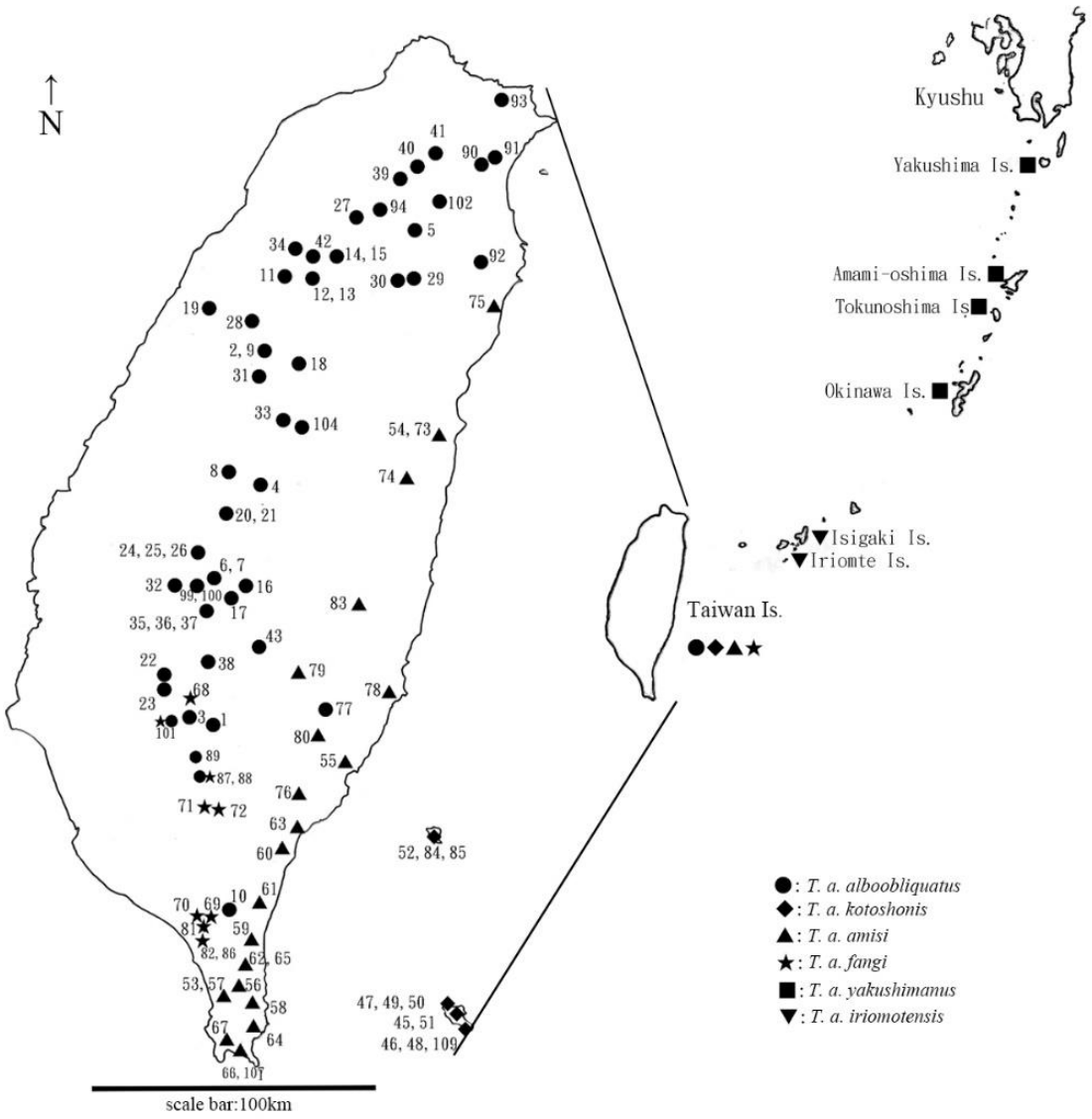

Figure 2. Distribution of *Therates alboobliquatus* ssp.

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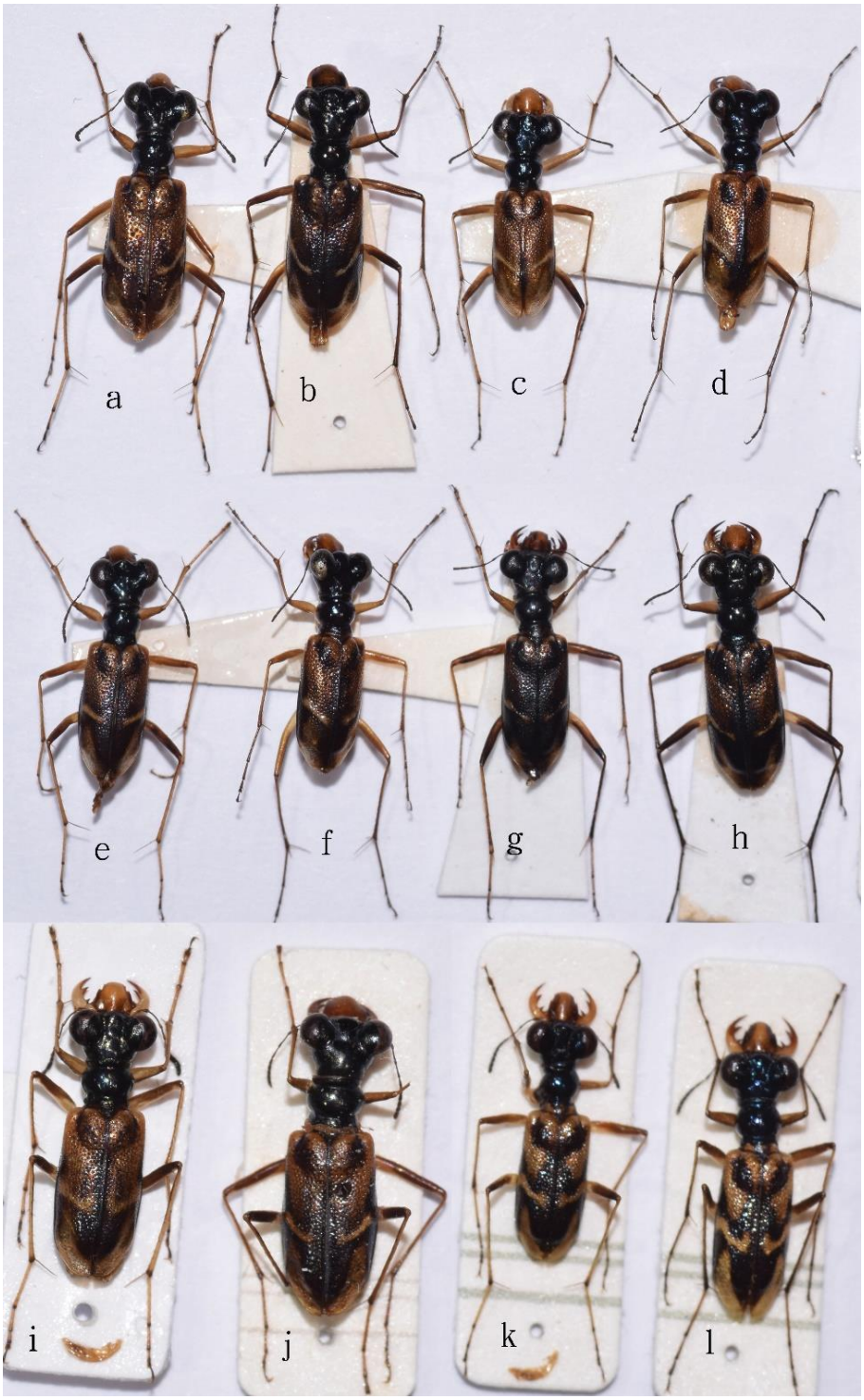

Figure 3a-l. Habitus of *Therates alboobliquatus* ssp. **3a, b)** *T. a. alboobliquatus* (Horn, 1909) ♂ / ♀. **3c, d)** *T. a. kotoshonis* Kano 1931 ♂ / ♀. **3e, f)** *T. a. amisi* new subspecies ♂ / ♀**3g, h)** *T. a. fangi* new subspecies ♂ / ♀. **3i, j)** *T. a. yakushimanus* Nakane 1955 ♂ / ♀. **3k, l)** *T. a. iriomotensis* Chujo 1970 ♂ / ♀.

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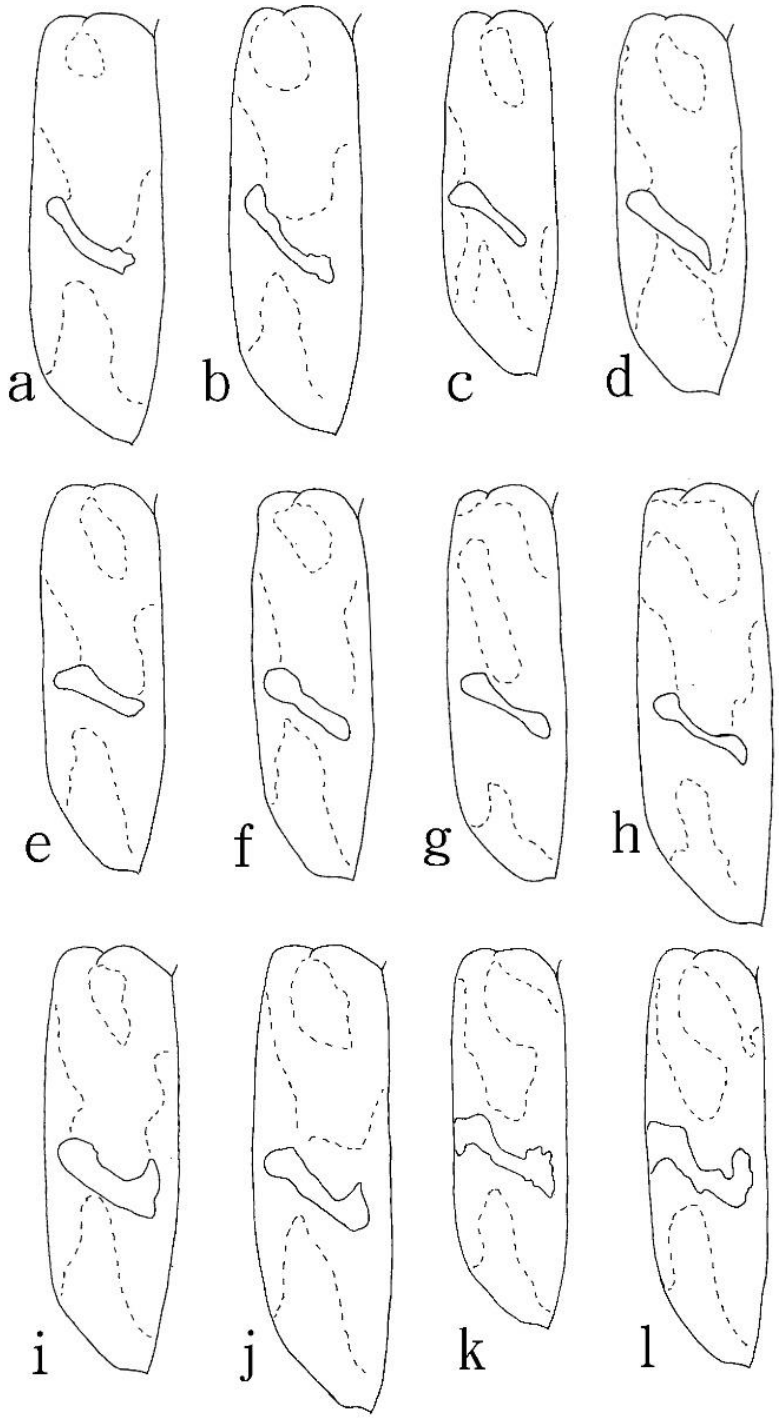

Figure 4a-l. Left elytron of *Therates alboobliquatus* ssp. **4a, b)** *T. a. alboobliquatus* (Horn, 1909) ♂ / ♀. **4c, d)** *T. a. kotoshonis* Kano 1931 ♂ / ♀. **4e, f)** *T. a. amisi* new subspecies ♂ / ♀. **4g, h)** *T. a. fangi* new subspecies ♂ / ♀. **4i, j)** *T. a. yakushimanus* Nakane 1955 ♂ / ♀. **4k, l)** *T. a. iriomotensis* Chujo 1970 ♂ / ♀.

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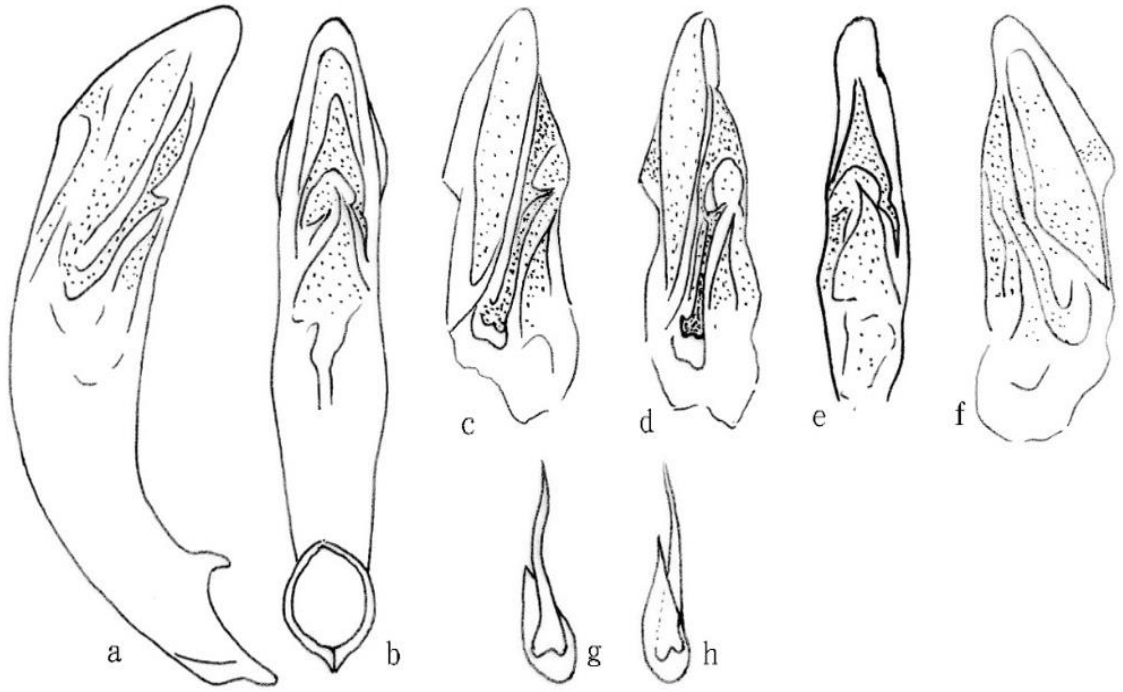

Figure 5a-h. Aedeagus of *T. a. alboobliquatus* (Horn, 1909). **5a, b.** Total view. **5a)** Left lateral view. **5b)** Dorsal view. **5c-f)** Inner sac. **5c)** Left lateral view. **5d)** Left dorsolateral view. **5e)** Dorsal view. **5f)** Right lateral view. **5g, h).** Pickaxed sclerite. **5g)** Left lateral view. **5h)** Right lateral view.

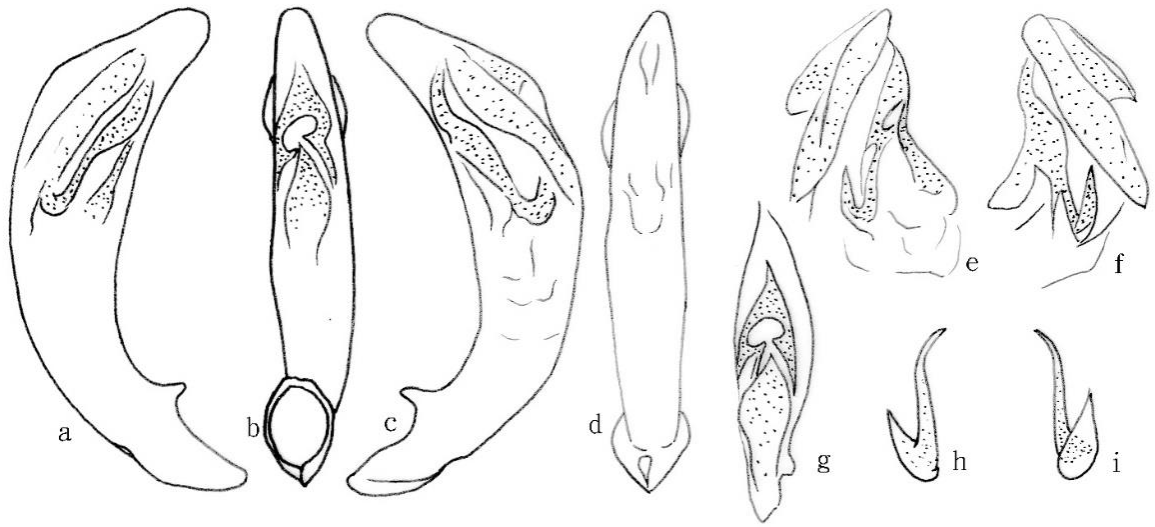

Figure 6a-i. Aedeagus of *T. a. kotoshonis* Kano 1931 **6a-d.** Total view. **6a)** Left lateral view. **6b)** Dorsal view. **6c)** Right lateral view. **6d)** Ventral view. **6e-g.** Inner sac (pulled apart). **6e)** Left lateral view. **6f)** Right lateral view. **6g)** Dorsal view. **6h, i.** Pickaxed sclerite. **6h)** Left lateral view. **6i)** Right lateral view.

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Therates alboobliquatus kotoshonis Kano 1931 (Fig. 3c, 3d, 4c, 4d, 6)

Localities. All collected from Taitung County. 2. VI. 1993, Lanyu Township, leg. Jen-Zon Ho, 1 ♂, 2 ♀ [**44**]; 27. VI. 2017, Lanyu Township, Hongtou Mt., alt. 280 m, 1 ♂ [**45**]; 31. V. 2018, Lanyu Township, Tianchi trail, alt. 140-350 m, 4 ♂, 7 ♀ [**46**]; 31. V. 2018, Lanyu Township, Small-Tianchi trail, 1 ♂, 1 ♀ [**47**]; 1. VI. 2018, Lanyu Township, Zhong'ai Bridge trail, alt. 45-130 m, 2 ♂ 3 ♀ [**48**]; 2. VI. 2018, Lanyu Township, Langdao Qidaoshan trail, alt. 160 m, 1 ♀ [**49**]; 2. VI. 2018, Lanyu Township, Small- Tianchi trail, 1 ♂ [**50**]; 3. VI. 2018, Lanyu Township,Hongtou Mt., alt. 250-552 m, 5 ♂ [**51**]; 6. V. 2020, Ludao Township, Amei Mt. trail 0.7k, 3 ♀ [**52**]; 5. V. 2021, Ludao Haicanping trail1, alt. 20-120 m, 4 ♀ [**84**]; 7. V. 2021, Ludao Township, Amei Mt. trail, alt. 200-270 m, 3 ♂, 1 ♀ [**85**].; 3. VI. 2018, Lanyu Township Hongtou Mt. alt. 250-552 m, 1 ♂, 1 ♀ [**109**]; 9. V. 1971, Lan-hsu, leg. K. Sakai, 1 ♀ [**110**].

Therates alboobliquatus amisi new subspecies (Fig. 3e, 3f, 4e, 4f, 7)

Type depository. Holotype ♂ in coll. Wiesner (long term loan of Zoologische Staatssammlung München, Germany). 2 paratype ♂ and 2 paratype ♀ in coll. Wiesner, 1 paratype ♂ and 1 paratype ♀ in coll. NMNS (National Museum of Natural Science, Taiwan), 1 paratype ♂ and 1 paratype ♀ in coll. TARI (Taiwan Agricultural Research Institute, Taiwan), 25 paratype ♂ and 20 paratype ♀ in coll. Lin.
Type status. Holotype ♂, type labels: "5. VII. 2008, Taitung County, Donghe Township, Doulan Mt., alt. 650-1000 m, leg. Tzong-Jenq Lin [printed, yellow]"; "HOLOTYPE *Therates alboobliquatus amisi* n. ssp., ded. Lin & Wiesner, 2022 [printed, red]". Paratype ♂ and ♀, type labels containing the text (in Chinese, when collected by the first author) quoted in section localities and the label "PARATYPE *Therates alboobliquatus amisi* n. ssp., ded. Lin & Wiesner, 2022 [printed, red]".
Diagnosis. Restricted to eastern Taiwan and Hengchun Peninsula. Distinguished by the shape of the middle band: linear, short, inner ends rounded, and the dark ground color of elytra.
Description. Size: Total length (without labrum) 6.5 - 8.7 mm (mean = 7.5 mm, n = 54). Head: Shining greenish black. Mandibles yellowish, teeth brownish marginally. Labrum as wide as long, yellowish, with six apical teeth and one lateral tooth. Labial and maxillary palpi yellowish. Antennae lanceolate, short, not reaching the elytral shoulders, scape with a single apical bristle, antennomeres 2 to 5 glabrous; antennomeres 6 to 11 finely and evenly pubescent; scape yellowish, all the remaining antennomeres brownish. Clypeus glabrous. Frons smooth with a transverse curved furrow in the posterior part of the orbital plates. Thorax: Pronotum shining greenish black, as long as wide, equally constricted in front and at back, transverse furrows strong, middle line and lateral lines nearly obsolete. Elytra: Shining black or dark brownish, with basal and apical humps, very coarse punctate in front, shallower towards apex. Maculation consists of a pale yellow, obliquely outwardly directed narrow middle band, the surface of which is slightly raised, a reddish brown or even lighter humeral lunule, nearly reaching or connected with the middle band, a long, reddish brown or even lighter basal dot, nearly reaching or connected with the humeral lunule, sparing a roundish area on the basal hump, and a long, isolated, reddish brown or even lighter apical lunule. (Fig. 4e, 4f). Apex with rounded lateral marginal corner and slightly extended suture corner, interspace straight or incurved. Ventral

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aspect: Venter black, abdominal segments dark brownish. Legs yellowish, tibiae and tarsomeres darkened distally. Aedeagus: (Fig. 7) stout and curved, total length 1.5 mm.

Etymology. The new subspecies is named after the Amis, an indigenous Austronesian group native to Taiwan. The traditional territory of the Amis includes the long, narrow valley between the Central Mountains and the Coastal Mountain, the Pacific coastal plain eastern to the Coastal Mountains and the Hengchun Peninsula.

Distribution. Eastern Taiwan and Hengchun Peninsula, floristic subdivisions 7-9 (Fig. 9).

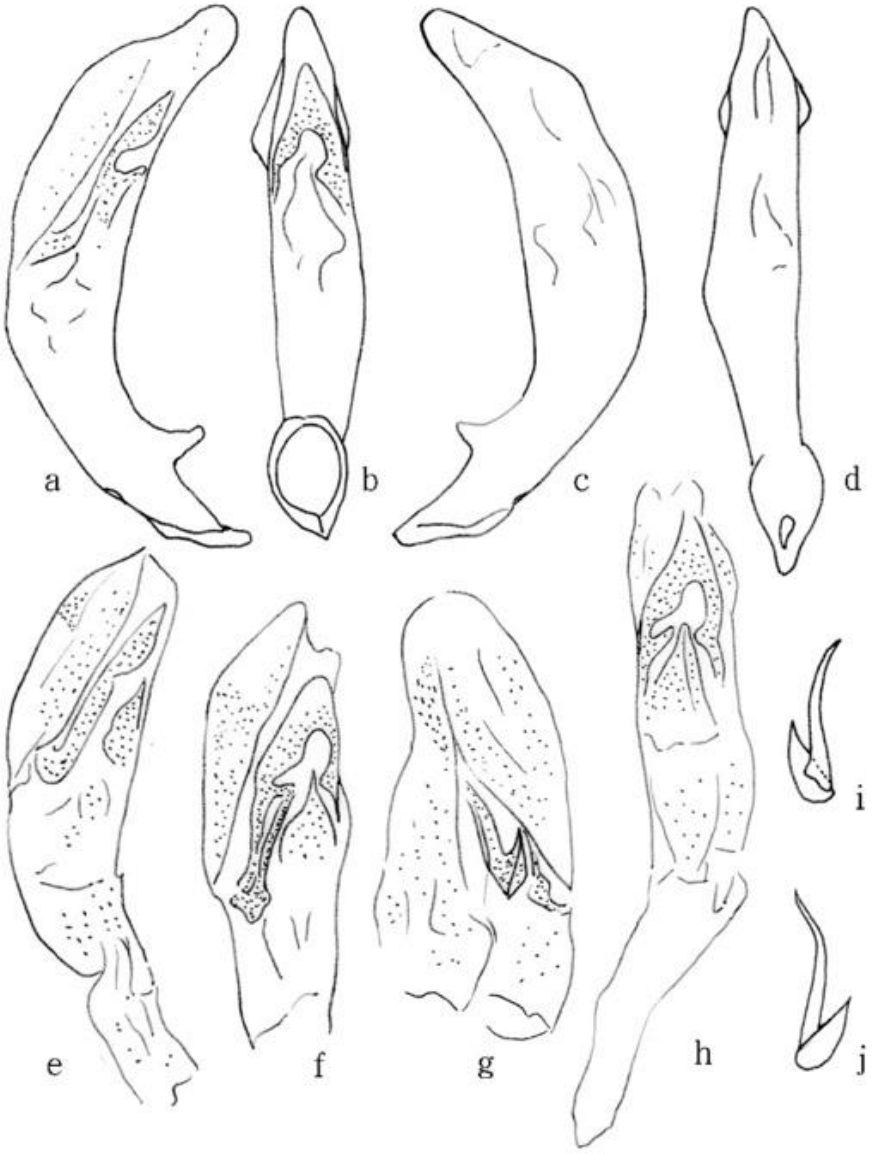

Figure 7a-j. Aedeagus of *T. a. amisi* new subspecies **7a-d.** Total view. **7a)** Left lateral view. **7b)** Dorsal view. **7c)** Right lateral view. **7d)** Ventral view. **7e-h.** Inner sac. **7e)** Left lateral view. **7f)** Left dorsolateral view. **7g)** Right lateral view. **7h)** Dorsal view. **7i, j.** Sclerite. **7i)** Left lateral view. **7j)** Right lateral view.

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JOURNAL OF TROPICAL COLEOPTEROLOGY
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Localities. 25. VIII. 2001, Pingtung County, Shizi Township, Lilong Mt., alt. 650-950 m, 5 ♂ [**53**]; 13. V. 2003, Hualien County, Xiulin Township, Chinan (N.F.R.A.), 2 ♂ [**54**]; 5. VII. 2008, Taitung County, Donghe Township, Doulan Mt., alt. 650-1000 m, 3 ♂, 5 ♀ [**55**]; 26. V. 2011; Pingtung County, Shizi Township, Shuangliu, Maozi Mt., alt. 500-600 m, 3 ♂, 2 ♀ [**56**]; 29. V. 2011, Pingtung County, Shizi Township, Lilong Mt., alt. 640 m, 1 ♀ [**57**]; 18. V. 2014, Pingtung County, Manzhou Township, Fenshuiling, 2 ♂, 1 ♀ [**58**]; 27. VI. 2014, Taitung County, Dawu Township, Nanxing main farm road, 1 ♂ [**59**]; 17. V. 2015, Taitung County, Jinfeng Township, Yazilan Mt., alt. 925 m, 1 ♀ [**60**]; 7. VI. 2015, Taitung County, Daren Township, Tuban, Xinxing main farm road, 1 ♀ [**61**]; 6. VI. 2015, Pingtung County, Shizi Township, Shouka S. 1.5k, 1 ♂ [**62**]; 15. V. 2015, Taitung County, Beinan Township, Zhiben, Baiyu waterfall, 1 ♀ [**63**]; 29. V. 2016, Pingtung County, Manzhou Township, Lanrenxi trail, alt. 300 m, 1 ♂, 1 ♀ [**64**]; 30. IV. 2016, Pingtung County, Shizi Township, Shouka N. 1k, 1 ♂ [**65**]; 30. V. 2016, Pingtung County, Hengchun Township, Kending (N.F.R.A.), 1 ♀ [**66**]; 1. V. 2016, Pingtung County, Hengchun Township, Chiniu Mt., alt. 280 m, 1 ♂, 1 ♀ [**67**]; 17. VIII. 2017, Hualien County, Shoufeng Township, Chinan, Liyu Mt. trail, alt. 280 m, 1 ♀ [**73**]; 18. VIII. 2017, Hualien County, Wanrong Township, Xilin Forest -road 9k, 1 ♂ [**74**]; 5. V. 2018, Yilan County, Nan'ao Township, Gaofeng, 1 ♂ [**75**]; 4. VI. 2018, Taitung County, Beinan Township, Lijia forest-road 15-16k, 1 ♂, 2 ♀ [**76**]; 23. V. 2019, Taitung County, Chenggong Township, Malaolou trail, alt. 375-400 m, 1 ♂, 1 ♀ [**78**]; 24. V. 2019, Taitung County, Haiduan Township, Lisong trail, alt. 1460 m, 1 ♀ [**79**]; 27. VI. 2019, Taitung County, Yanping Township, Wuling Forest -road, alt. 965 m, 2 ♂, 1 ♀ [**80**]; 21. VI. 2020, Hualien County, Zhuoxi Township, Zhongping Forest-road, alt. 946-1103 m, 2 ♂, 1 ♀ [**83**]. 3. V. 1981, Kenting, leg. Michio Hori, 1 ♂, 1 ♀ [**107**]; 23. V. 2019, Taitung County, Chenggong Township, Malaolou trail, alt. 375-400 m, 1 ♂, 1 ♀ [**108**].

Therates alboobliquatus fangi new subspecies (Fig. 3g, 3h, 4g, 4h, 8)

Type depository. Holotype ♂ in coll. Wiesner (long term loan of Zoologische Staatssammlung München, Germany). 3 paratypes ♂ in coll. Wiesner, 1 paratype ♂ and 1 paratype ♀ in coll. NMNS (Taiwan), 1 paratype ♂ and 1 paratype ♀ in coll. TARI (Taiwan), 9 paratype ♂ and 6 paratype ♀ in coll. Lin.

Type status. Holotype ♂, type labels: "14. V. 2020, Pingtung County, Chunri Township, Beihulyu Mt., alt. 980-1337 m, leg. Tzong-Jenq Lin [printed, yellow]"; "HOLOTYPE *Therates alboobliquatus fangi* n. ssp., ded. Lin & Wiesner, 2022 [printed, red]". Paratype ♂ and ♀, type labels containing the text quoted in section localities (in Chinese, when collected by the first author) and the label "PARATYPE *Therates alboobliquatus fangi* n. ssp., ded. Lin & Wiesner, 2022 [printed, red]".

Diagnosis. Restricted to southwestern Taiwan and distinguished by the shape of the middle band: linear, tapered in the middle, both ends equally inflated.

Description. Size: Total length (without labrum) 7.0 - 8.9 mm (mean = 7.7 mm, n = 23). Head: Shining greenish black. Mandibles yellowish, teeth brownish marginally. Labrum as wide as long, yellowish, with six apical teeth and one lateral tooth. Labial and maxillary palpi yellowish. Antennae lanceolate, short, not reaching the elytral shoulders, scape with a single apical bristle, antennomeres 2 to 5 glabrous; antennomeres 6 to 11 finely and evenly pubescent; scape

DOI: https://doi.org./10.53716/jtc.3.1.8.2022
ZOOBANK: https://zoobank.org/References/345DA4D2-7746-43BB-A5CD-8B6737BDFF08
Received: 29 April 2022
Published: 30 July 2022
www.jtcoleop.com

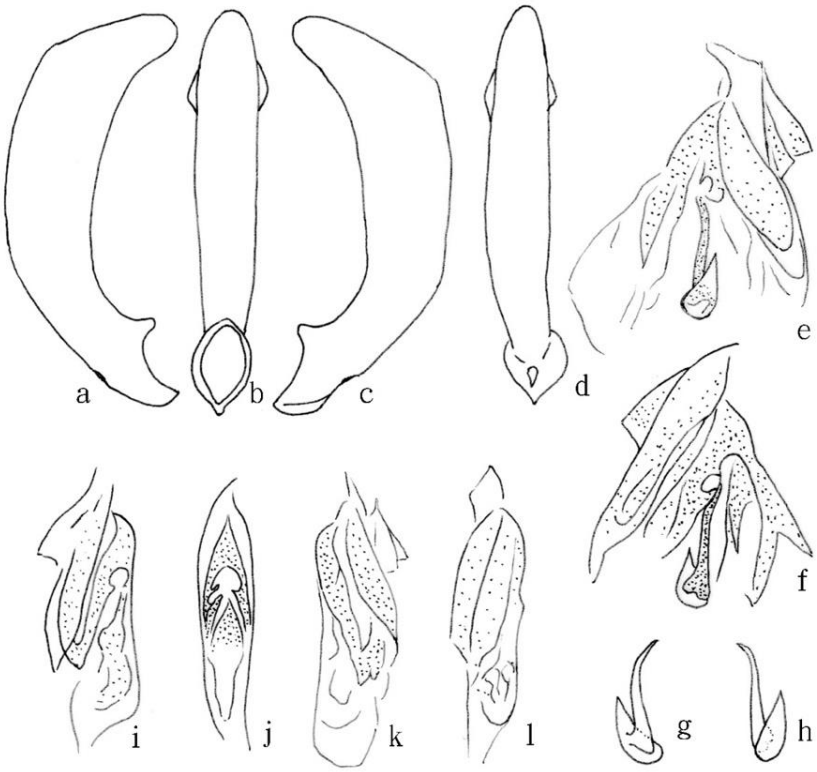
Jour. Trop. Coleop. 3(1), 55-73
JOURNAL OF TROPICAL COLEOPTEROLOGY
ISSN online 2718-9740 ; print 2719-1486

yellowish, all the remaining antennomeres brownish. Clypeus glabrous. Frons smooth with a transverse curved furrow in the posterior part of the orbital plates. Thorax: Pronotum shining greenish black, as long as wide, equally constricted in front and at back, transverse furrows strong, middle line and lateral lines nearly obsolete. Elytra: Shining black, with basal and apical humps, very coarse punctate in front, shallower towards apex. Maculations consist of a pale yellow, obliquely outwardly directed band that is narrowed in the middle, and narrow middle band, the surface of which is slightly raised, a reddish brown humeral lunule, nearly reaching or connected with the middle band, a long, reddish brown basal dot, nearly reaching or connected with the humeral lunule, sparing a roundish area on the basal hump, and a long, isolated, reddish brown apical lunule. (Fig. 4g, 4h). Apex with rounded lateral marginal corner and slightly extended suture corner, interspace straight or incurved. Ventral aspect: Venter black, abdominal segments dark brownish. Legs yellowish, tibiae and tarsomeres darkened distally. Aedeagus: (Fig. 8) stout and curved, total length 1.7 mm.

Etymology. The new subspecies is dedicated to the late Dr. Huai-Sheng Fang, an entomologist and former chief of Low Altitude Experimental Station (ESRI, Taiwan), who devoted himself to conservation work for decades. At the beginning of his conservation career, the first author was mentored by Dr. Fang.

Distribution. Southwestern Taiwan, floristic subdivisions 6 (Fig. 9).

Figure 8a-h. Aedeagus of *T. a. fangi* new subspecies **8a-d.** Total view. **8a)** Left lateral view. **8b)** Dorsal view.



8c) Right lateral view. **8d)** Ventral view. **8e, f.** Inner sac (pulled apart). **8e)** Left lateral view. **8f)** Right lateral view. **8g, h.** Sclerite. **8g)** Left lateral view. **8h)** Right lateral view. **9i-l.** Inner sac. **8i)** Left lateral view. **8j)** Dorsal view. **8k)** Right lateral view. **8l)** Ventral view.

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Localities. 14. V. 2016, Kaohsiung City, Jiaxian District, Wuzhiliao, Wuzhiliao-Forest-road, alt. 800 m, 1 ♀ [68]; 29. V. 2017, Pingtung County, Chunri Township, Dahan Forest-road 20.2k, alt. 1235 m, 1 ♀ [69]; 29. V. 2017, Pingtung County, Chunri Township, Dahan Forest-road 16k, alt. 1000 m, 1 ♀ [70]; 12. VI. 2017, Pingtung County, Sandimen Township, Dewen Mt., alt. 1050-1230 m, 2 ♂ [71]; 13. VI. 2017, Pingtung County, Wutai Township, Jingbu Mt., alt. 1185 m, 2 ♂ [72]; 14. V. 2020, Pingtung County, Chunri Township, Beihulyu Mt., alt. 980-1337 m, 1 ♂, 2 ♀ [81]; 15. V. 2020, Pingtung County, Chunri Township, Nanhulyu Mt., alt. 688-723 m, 3 ♂, 1 ♀ [82]; 27. V. 2021, Pingtung County, Chunri Township, Nanhulyu Mt., alt. 689 m, 4 ♂, 1 ♀ [86]; 28. V. 2021, Pingtung County, Sandimen Township, Weiliao Mt., alt. 1224 m, 1 ♀ [87]; 19-26. V. 1908, Kosempo, leg. Sauter, 3 ♂ [101].

Therates alboobliquatus yakushimanus Nakane 1955 (Fig. 3i, 3j, 4i, 4j)

Localities. 26. VIII. 1974, Loochoos, leg. S. Okajima, 1 ♀ [**111**]; 16-17. VII. 2012, Nagata leg., 1 ♂, 1 ♀ [**112**].

Therates alboobliquatus iriomotensis Chujo 1970 (Fig. 3k, 3l, 4k, 4l)

Localities. 11. V. 1974, Omoto Mt., leg. O. Tamura, 1 ♂, 1♀ [113]; 27. VI. 1977, Sonai, leg. H. Hiramatsu, 1 ♀ [114]; 23. VII. 1979, Omoto Mt., leg. Y. Thoki, 1 ♂ [115]; 12. V. 2012, Sonai-dake, leg. T. Nakata, 1 ♂, 1♀ [116]; 25. VI. 2012, Yarabu, leg., 1 ♂ [117].

Identification key to the subspecies of *Therates alboobliquatus* (Horn, 1909)

1. Middle bands twisted (Fig. 4i, 4j, 4k, 4l) or bended (Fig. 4a, 4b) **2**
—Middle bands linear (Fig. 4c, 4d, 4e, 4f, 4g, 4h) **4**

2(1). Body size smaller (7.0 - 8.1 mm, mean = 7.4 mm), middle bands outer ends connected with margins (Fig. 4k, 4l); from Iriomote and Isigaki Is. ..... ***T. a. iriomotensis*** Chujo 1970
—Body size larger (6.9 - 9.3 mm, mean = 8.4 mm), middle bands outer ends not connected with margins (Fig. 4a, 4b, 4i, 4j) **3**

3(2). Middle bands somewhat thick and straight, inner ends hooked (Fig. 4i, 4j); from Okinawa Is. up to Yakushima Is. ..... ***T. a. yakushimanus*** Nakane 1955
—Middle bands curved, both ends slightly enlarged, inner ends rarely hooked (Fig. 4a, 4b) ..... ***T. a. alboobliquatus*** (Horn, 1909)

4(1). Middle bands tapered in the middle, both ends inflated equally, dumbbell-shaped (Fig. 4g, 4h); from southwest Taiwan ..... ***T. a. fangi*** **new subspecies**
—Middle bands not tapered in the middle (Fig. 4c, 4d, 4e, 4f) **5**

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5(4). Elytral ground color pale; middle bands longer (Fig. 4c, 4d); from Lanyu and Ludao Is. ....***T. a. kotoshonis*** Kano 1931
—Elytra ground color dark, middle bands shorter, (Fig. 4e, 4f); from eastern Taiwan ....***T. a. amisi*** **new subspecies**

Discussion

Geographic isolation

Geographic isolation is an important factor in delimiting species or subspecies of tiger beetles (Knisley and Haines 2007: 114, Mawdsley 2009: 1). The subspecies of *T. alboobliquatus* ssp. are highly isolated on islands. *T. a. kotoshonis* occurs on Lanyu Is. and Ludao Is.; *T. a. iriomotensis* on Iriomote Is. and Isigaki Is.; *T. a. yakushimanus* on Yakushima Is., Amami-oshima Is., Tokunoshima Is. and Okinawa Is. Another three subspecies occur on the large island of Taiwan. *T. a. alboobliquatus* and *T. a. fangi* are found along the west side of the Central Mountain Range and *T. a. amisi* is restricted to the east side of these mountains and Hengchun Peninsula. These two populations are isolated from each other by the Central Mountain Range (C. M. R.), which runs northwest to east-southeast and consists of more than 180 peaks above 3000 m. The (C. M. R.) have an isolated effect for the trees distributed under 2000 m elevation (Huang 2011: 48). This upper limit of tree availability is an important factor restricting the elevational range for the larvae of *Therates* spp. that inhabit rotten wood of broadleaf trees. At higher altitudes (over 2500 m) mostly conifer trees dominate (Su 1991: 43, tab.1).

There is some evidence of similar geographic isolations for other groups of animals of Taiwan. The Light-vented Bulbuls (*Pycnonotus sinensis formosae* Hartert, 1910) is distributed mostly in western and northern Taiwan, and Taiwan Bulbuls (*Pycnonotus taivanus* Styan, 1893) are distributed mostly in eastern and southern Taiwan (Hachisuka and Udagawa 1951: 28-29). This distribution pattern of two sibling birds resembles that of *T. a. amisi* and *T. a. alboobliquatus*. The distribution of *T. a. alboobliquatus* also resembles that of the firefly, *Pyrocoelia analis* (Fabricius, 1801) that occurs mostly in western and northern Taiwan (Ho 2004: 123, fig. 6). According to recent observations by the first author, the most likely boundary between *T. a. alboobliquatus* and *T. a. amisi* is on Nan'ao, in northwestern Taiwan; between *T. a. amisi* and *T. a. fangi* it is on Feng-gang, south Taiwan. Although a distinct physical isolating mechanism between *T. a. fangi* and *T. a. alboobliquatus* is not obvious, the distribution of these three subspecies resembles that of two sibling tree-frogs in Taiwan. *Buergeria choui* Matsui & Tomonaga, 2020 is distributed in northern and western Taiwan and Yaeyama Is.; *B. otai* Wang, Hsiao, Lee, Tseng, Lin, Komaki, and Lin. 2020 (Wang et. al., 2020: 10-11) comprises two lineages distributed in eastern and southern Taiwan respectively (Wang et. al. 2017: 3, fig. 1c). The shared characteristics of *Buergeria* tree-frogs and *Therates* tiger beetles were adults with limited dispersal abilities and juvenile's dependent on specialized habitat (waterbody for tadpole / rotten wood for larva).

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JOURNAL OF TROPICAL COLEOPTEROLOGY
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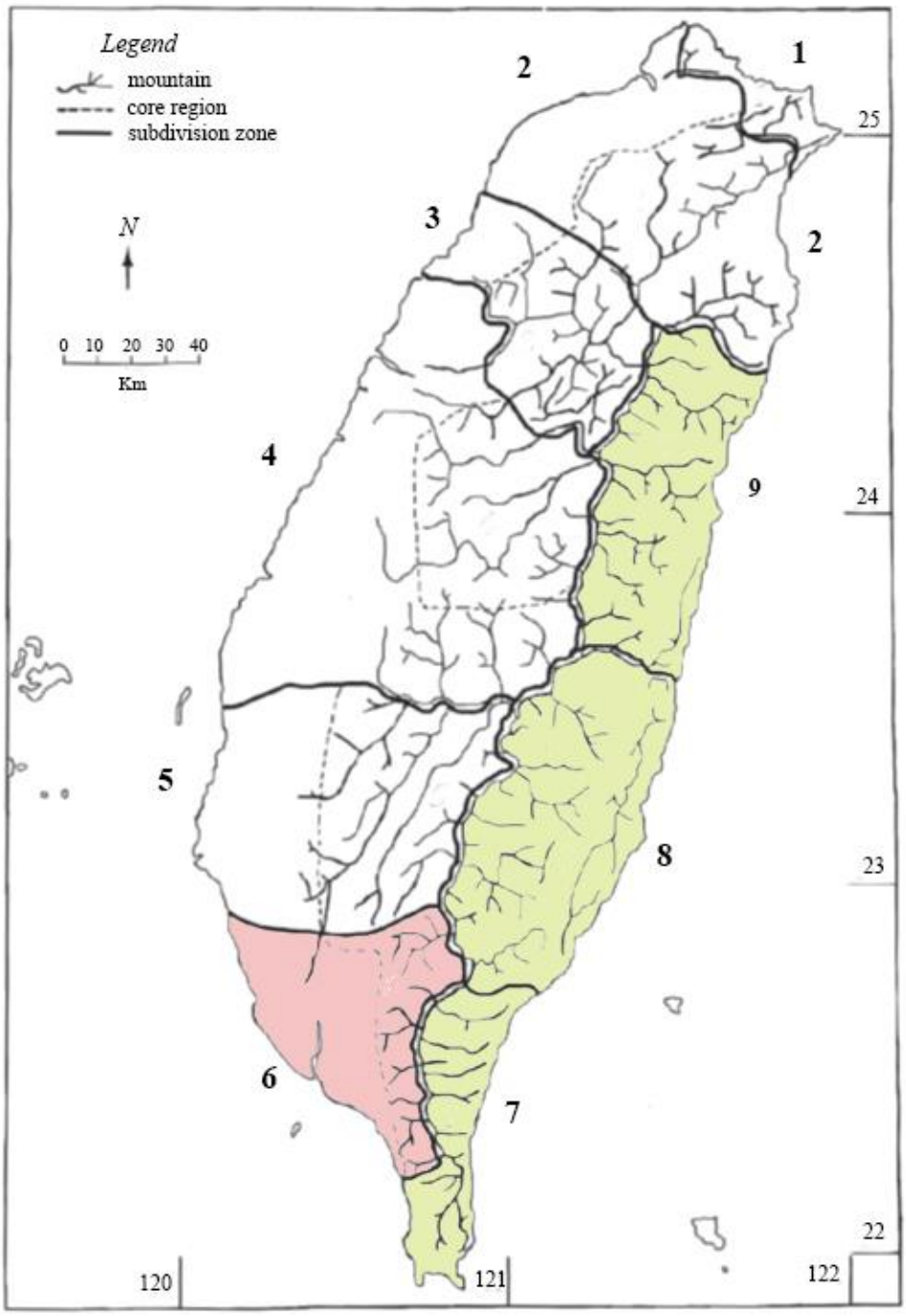

Figure 9. Floristic subdivisions of climatic zones in Taiwan (cited from Huang 2011: 54, fig. 4). *T. a. alboobliquatus* distributed in subdivisions 1-5 (western and northern Taiwan); *T. a. fangi* distributed in subdivision 6 (southwestern Taiwan); *T. a. amisi* distributed in subdivisions 7-9 (eastern Taiwan).

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Relationship between climate and elevation

Besides the geographical barrier, the differential climate caused by latitude and altitude may have sufficiently isolated the three populations that evolved into subspecies of *T. alboobliquatus* in Taiwan. These physical factors include mean annual temperature, average annual precipitation, and floristic elements (Su 1985: 33, 1991: 48, fig. 3) based on the phylogeographical distribution of plants divided into nine divisions (Huang 2011: 35) (Fig. 9).

Altitudinal boundaries dividing other sibling species of tiger beetle species in Taiwan are known. For example, the *Cylindera cylindriformis* (Horn, 1912) occurs only in low elevation while the closely related *C. triangulata* Lin and Acciavatti, 2019 is found in higher elevation area of the Hengchen Peninsula of southern Taiwan (Lin 2019: 304). Similarly, the firefly *Pyrocoelia analis* (Fabricius, 1801) occurs only below 500 m and *Pyrocoelia praetexta* Olivier, 1911 between 100 and 2000 m (Ho 2002: 31-32).

From our data, the elevation of *T. a. alboobliquatus* ranged from 800 to 2300 m, except two localities on northern Taiwan down to around 400 to 500 m; in *T. a. amisi* mostly under 1000 m (only one record at 1460 m) and lowest elevation is 100 m; the distributed elevation of *T. a. fangi* between 700 to 1300 m, both subspecies relatively lower than *T. a. alboobliquatus*. As to those subspecies distributed in islands, the distributed elevation is lower as. *T. a. kotoshonis* ranged from 550 m to 20 m; the islands inhabited by *T. a. iriomotensis* of that highest elevation about 500m and *T. a. yakushimanus* have been collected around 300 to 650 m (Kubota and Kanai 2011: 38).

Intra-subspecific variation of maculation

The external morphological of adult characters, especially the elytral maculations, are the most useful and constantly for distinguishing populations of *T. alboobliquatus* (Knisley et. al. 2008: 277). In *T. alboobliquatus*, the shape of middle band and ground color of elytra with a clinal variation between subspecies. If the long middle band and light ground color of the *T. a. kotoshonis* population on Orchid Island (Lanyu) is taken as the basal maculation pattern for the species, then *T. a. kotoshonis* on Green Island (Ludao, a small island closer to Taiwan than Lanyu), has a middle band the same as the population in Orchid Island (Lanyu) but with a darker ground color. *T. a. amisi* from eastern Taiwan, has an even darker ground color and a shorter middle band. The adjacent subspecies *T. a. fangi* has a similarly dark ground color but the middle band is slightly concaved in the middle. Neighboring *T. a. alboobliquatus* also shares a dark ground color (but some individuals of higher elevation with pale ground color) but the middle band is even more curved (but some individuals have maculation similar to *T. a. yakushimanus*, the more northern subspecies). From the varied middle band and ground color of *T. alboobliquatus* ssp. in Taiwan, a pattern of middle bands and ground color changes are roughly correlated with geographic factors such as altitude/elevation.

Comparison of size, markings, color, and male genitalia

In HW (Table 1), showed both sexes of *T. a. alboobliquatus* and *T. a. yakushimanus* with slightly wider head width than others, but in the female of *T. a. alboobliquatus* with higher variation. While in EL, EW and AE, also revealed that both sexes of *T. a. alboobliquatus* and *T. a. yakushimanus* have obvious differences to the other ssp (*kotoshonis*, *iriomotensis*, *amisi* and *fangi*). In HSW, *T. a. iriomotensis* broader than the other ssp. and *T. a. kotoshonis* narrowest; *T. a. alboobliquatus* and *T. a. yakushimanus* having closed mean values. In MBL, male of *T. a. iriomotensis* longest, while

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JOURNAL OF TROPICAL COLEOPTEROLOGY
ISSN online 2718-9740 ; print 2719-1486

male of *T. a. amisi* shorter than the others. In MBW, *T. a. yakushimanus* broadest and *T. a. alboobliquatus* secondly, male of *T. a. kotoshonis* and both sexes of *T. a. fangi* narrowed than the

Table 1. Measurements (average values with standard deviation and median) of *T. alboobliquatus* spp.

Character	sex	*T. a. alboobliquatus* m = 67, f = 38	*T. a. kotoshonis* m = 19, f = 24	*T. a. amisi* m = 31, f = 23	*T. a. fangi* m = 14, f = 9	*T. a. iriomotensis* m = 4, f = 3	*T. a. yakushimanus* m = 1, f = 2
Total body length	m	8.14 ± 0.41 (8.10)	6.86 ± 0.28 (6.9)	7.21 ± 0.42 (7.20)	7.37 ± 0.28 (7.25)	7.20 ± 0.14 (7.25)	8.3
	f	8.63 ± 0.36 (8.65)	7.20 ± 0.35 (7.25)	7.85 ± 0.49 (7.8)	8.28 ± 0.50 (8.20)	7.63 ± 0.57 (7.80)	8.45 ± 0.49 (8.45)
Width of head (HW)	m	2.49 ± 0.12 (2.50)	2.36 ± 0.11 (2.35)	2.32 ± 0.13 (2.30)	2.30 ± 0.11 (2.30)	2.34 ± 0.05 (2.33)	2.65
	f	2.67 ± 0.12 (2.70)	2.48 ± 0.12 (2.50)	2.52 ± 0.16 (2.50)	2.57 ± 0.16 (2.55)	2.43 ± 0.21 (2.50)	2.75 ± 0.07
Length of left elytron (EL)	m	5.20 ± 0.28 (5.15)	4.26 ± 0.21 (4.30)	4.52 ± 0.30 (4.50)	4.62 ± 0.18 (4.55)	4.51 ± 0.09 (4.53)	5.3
	f	5.56 ± 0.27 (5.55)	4.51 ± 0.25 (4.55)	4.95 ± 0.33 (4.90)	5.24 ± 0.34 (5.20)	4.80 ± 0.36 (4.90)	5.45 ± 0.35
Maxima width of elytra (EW)	m	2.55 ± 0.14 (2.50)	2.14 ± 0.10 (2.10)	2.25 ± 0.12 (2.30)	2.31 ± 0.11 (2.30)	2.25 ± 0.06 (2.25)	2.6
	f	2.75 ± 0.15 (2.80)	2.30 ± 0.13 (2.30)	2.47 ± 0.15 (2.40)	2.59 ± 0.17 (2.60)	2.37 ± 0.15 (2.40)	2.8 ± 0.14
Approximate superficial area of elytra (AE)	m	13.26	9.12	10.17	10.67	10.15	13.78
	f	15.29	10.37	11.98	13.57	11.38	15.26
Distance between left middle band inner end and suture (D)	m	0.25 ± 0.07 (0.25)	0.20 ± 0.05 (0.20)	0.28 ± 0.05 (0.25)	0.21 ± 0.05 (0.20)	0.14 ± 0.02 (0.15)	0.15
	f	0.27 ± 0.07 (0.25)	0.22 ± 0.07 (0.20)	0.31 ± 0.06 (0.30)	0.25 ± 0.07 (0.25)	0.15 ± 0.00 (0.15)	0.30 ± 0.00
Width at the midst of left middle band (MBW)	m	0.16 ± 0.04 (0.15)	0.11 ± 0.02 (0.10)	0.14 ± 0.04 (0.15)	0.11 ± 0.02 (0.10)	0.21 ± 0.02 (0.20)	0.25
	f	0.17 ± 0.04 (0.15)	0.14 ± 0.08 (0.10)	0.15 ± 0.02 (0.15)	0.11 ± 0.02 (0.10)	0.18 ± 0.03 (0.20)	0.25 ± 0.07
Width at the midst of left humeral dark spot (HSW)	m	0.36 ± 0.15 (0.35)	0.27 ± 0.07 (0.30)	0.39 ± 0.07 (0.40)	0.41 ± 0.07 (0.40)	0.53 ± 0.03 (0.53)	0.35
	f	0.48 ± 0.23 (0.40)	0.32 ± 0.04 (0.30)	0.44 ± 0.05 (0.40)	0.50 ± 0.09 (0.50)	0.52 ± 0.03 (0.50)	0.48 ± 0.11
Length of left middle band (MBL)	m	1.31 ± 0.16 (1.30)	1.20 ± 0.10 (1.20)	1.05 ± 0.10 (1.05)	1.13 ± 0.06 (1.15)	1.36 ± 0.05 (1.38)	1.4
	f	1.42 ± 0.17 (1.40)	1.23 ± 0.08 (1.25)	1.19 ± 0.14 (1.20)	1.29 ± 0.09 (1.30)	1.42 ± 0.08 (1.40)	1.28 ± 0.04
Slope of left middle band (SMB)	m	0.79 ± 0.16 (0.78)	0.91 ± 0.08 (0.88)	0.8 ± 0.13 (0.80)	0.69 ± 0.10 (0.69)	0.60 ± 0.08 (0.60)	0.57
	f	0.85 ± 0.15 (0.87)	0.93 ± 0.10 (0.93)	0.78 ± 0.14 (0.82)	0.73 ± 0.12 (0.76)	0.68 ± 0.02 (0.67)	0.62 ± 0.03

others but female of *T. a. kotoshonis* with higher variation. In D, the gap of *T. a. iriomotensis* shorter than the others and male of *T. a. amisi* broader than the others, while the other ssp. showed less differentiated since mean values largely overlap. In S, higher mean values in both sexes of *T. a. kotoshonis* and lower in males of *T. a. iriomotensis* and *T. a. yakushimanus*.

Outline of middle bands (Fig. 3, 4): in *T. a. alboobliquatus*, it curved than other species and asymmetric, bottom section more curved than outer ends, inner ends seldom inflated upward,

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but the northern individuals inflated upward more and obvious, some higher altitude individuals ground color pale; in *T. a. kotoshonis*, middle bands slender, its outer ends enlarged and rounded gradually tapering toward to inner ends; in *T. a. yakushimanus*, it similar to *T. a. alboobliquatus* but more stout, inner ends upward with hook shape; in *T. a. iriomotensis*, it curved, outer ends usually enlarged and revers downward connected to elytra margins, inner ends enlarged upward and closed to suture, particular and recognizable than others; in *T. a. amisi*, it more stout than *T. a. kotoshonis* and with both ends rounded; in *T. a. fangi*, it more thin at middle section than others and both ends rounded too.

Ground color of the elytra varied within each subspecies, but *T. a. kotoshonis*, tended to be lighter than others; *T. a. iriomotensis*, had saturated and clear boundary between the color patches.

Based on the body size (HW, EL, EW, AE, Table 1), the subspecies can be divided into two groups, one with larger body size (*T. a. alboobliquatus* and *T. a. yakushimanus*) and similar markings and another with smaller body size (*T. a. kotoshonis*, *T. a. iriomotensis*, *T. a. amisi* and *T. a. fangi*), where *T. a. kotoshonis*, *T. a. amisi* and *T. a. fangi* have similar markings, while *T. a. iriomotensis* has more particular markings. *T. a. kotoshonis* can be distinguished from *T. a. amisi* and *T. a. fangi* by longer middle bands, pale elytra color and their geographic distribution. The difference between *T. a. a*misi and *T. a. f*angi are shape of middle bands and geographic distribution.

The inner sac of the aedeagus is made up of slightly sclerotic thin or thick membranes (Higley 1986: 304) with inner sac folding irregular shape in inside. In left lateral aspect, it may divide into left and right part that joined by thin membranes; left part concaved, with an opening at outside (left side) namely apical orifice; right part beak-shaped with a tiny sclerite (Fig. 5g, 5h, 6h, 6i, 7i, 7j, 8g, 8h). It seems no significant variation in the structure of inner sac between *T. alboobliquatus* ssp. of Taiwan, but the profile and size of aedeagus with more obvious variations. The size and shape of aedeagus were slightly but notable difference among *T. a. alboobliquatus* (Fig. 5), *T. a. kotoshonis* (Fig. 6) and *T. a. amisi* (Fig. 7), but inconspicuous between *T. a. amisi* and *T. a. fangi* (fig. 8). For the size of aedeagus, *T. a. alboobliquatus* is large (range from 1.7 to 2.0 mm, average 1.83 mm, n = 6) and consistent to the large body size of the beetle, but with more intraspecific variation; *T. a. kotoshonis* (range from 1.41 to 1.6 mm, average 1.51 mm, n = 6); *T. a. amisi* (range from 1.5 to 1.6 mm, average 1.55 mm, n = 5) and *T. a. fangi* (all are 1.5 mm, n = 3). The apical portion of aedeagus curved in lateral view, *T. a. fangi* more bent than the other subspecies of Taiwan, apical portion robust and shortly than *T. a. amisi*. In contrary, *T. a. amisi* with more prolonged apical portion. *T. a. kotoshonis* with the same degree of bent as *T. a. amisi* in the apical portion of aedeagus but more robust and not prolonged. *T. a. alboobliquatus* really straight than other subspecies of Taiwan. The lateral flanges of aedeagus also with difference, *T. a. kotoshonis* small and not pronounced; *T. a. amisi* and *T. a. fangi* slightly pronounced; *T. a. alboobliquatus* more pronounced than others.

Competing interest

The authors declared that there is no competing interests exist in the preparation of the manuscript.

Acknowledgement

The authors are indebted to Mandy Schröter (SDEI, Müncheberg) for loan of the holotype of *Therates alboobliquatus* and to David L. Pearson (Tempe, Arizona) for proof reading of the manuscript. First author is also grateful to Sue-Cheng Lin (Taichung, Taiwan) for advice and Ching-Yu Liou (ESRI, Taiwan) for support.

DOI: https://doi.org./10.53716/jtc.3.1.8.2022
ZOOBANK: https://zoobank.org/References/345DA4D2-7746-43BB-A5CD-8B6737BDFF08
Received: 29 April 2022
Published: 30 July 2022
www.jtcoleop.com

REFERENCES

Chujo M. 1970. Coleoptera of the Loo-choo Archipelago (II). Family Cicindelidae. *Memoirs of the faculty of education, Kagawa University* 2(192): 1-3.

Hachisuka M, Udagawa T. 1951. Contributions to the Ornithology of Formosa. pt. II. *Quarterly Journal of the Taiwan Museum* 4(1-2): 1-180.

Ho JZ. 2002. *Larval morphology of twenty-one species and bionomics of firefly (Coleoptera: Lampyridae) in Taiwan.* 180 pp. Doctoral Dissertation of Department of Entomology, National Chung Hsing University (in Chinese).

Ho JZ. 2004. Occurred fluctuation, distribution, and habitat characters of the firefly, Pyrocoelia analis. *Formosan Entomologist* 24: 117-128, (in Chinese).

Horn W. 1909. On three new Cicindelidae Notes from the Leyden Museum. 32: 186-187.

Higley, L. G. 1986. Morphology of Reproductive Structures in *Cicindela repanda* (Coleoptera: Cicindelidae). *Journal of The Kansas Entomological Society* 59(2): 303-308.

Huang SF. 2011. Historical Biogeography of the flora of Taiwan. *Quarterly Journal of the Taiwan Museum* 64(3): 33-63 (in Chinese).

Kano T. 1931. Description of two new species of Formosan Cicindelidae (Col.) *Proccedings of the Imperial Academy* 7(2): 69.

Knisley CB, Haines RD. 2007. Description and conservation of a new subspecies of *Cincindela tranquebarica* (Coleoptera: Cicindelidae), from the San Joaquin Valley of California, U. S. A. *Entomological News* 118(2): 109-126.

Knisley CB, Woodcock MR, Vogler AP. 2008. A new subspecies of *Cicindela limbata* (Coleoptera: Cicindelidae) from Alaska, and further review of the *maritima* group by using mitochondrial DNA analysis. *Annals of the Entomological Society of America* 101(2): 277-288.

Kubota Y, Kanai K. 2011. Vertical distribution of beetles collected with FIT, feces, and carrion (two *Phelotrupes* spp., *Bolbocerosoma nigroplagiatum*, and two others) on the Yakushima Island (in Japanese). *Bulletin of the Kagoshima prefectural Museum* 30: 37-42.

Lin TJ. 2014. Description of the immatures of tiger beetles (Coleoptera: Cicindelidae) from Taiwan (II). *Formosan Entomologist* 34: 97-128.

Lin TJ. 2019. Description of *Cylindera* (*Cylindera*) *triangulata,* sp. nov., and its comparison with *Cylindera* (*Cylindera*) *cylindriformis* (Horn, 1912) (Coleoptera: Cicindelidae) in Taiwan. *Journal of Experimental Forest of National Taiwan University* 33(4): 295-310.

Miwa Y. 1936. Family Cicindelidae, Class Insecta Coleopteroidea-Coleoptera. *Fauna Nipponica* 10(4): 1-98 (in Japanese).

Mawdsley JT. 2009. Geographic variation in U. S. populations of the tiger beetle *Cicindela obsolete* Say (Coleoptera: Cicindelidae). *Insecta Mundi* 0094: 1-10.

Nakane T. 1955. New or little-known Coleoptera from Japan and its adjacent regions, XII. Scientific reports of the Saikyo University. *Natural science and living science* 2(A): 24-40, pls. 1-3.

Su HJ. 1985. Studies on the Climate and Vegetation Types of the Natrual Forests in Taiwan: (III) A Scheme of Geographical Climatic Regions. *Quarterly Journal of Chinese Forestry* 18(3): 33-44.

Su HJ. 1991. Vegetation of Taiwan: Altitudinal vegetation zone and geographical climatic regions. *Institute of Botany, Academia Sinica Monograph Series* 11: 39-53.

Wang YH, Hsiao YW, Lee KH, Tseng HY, Lin YP, Komaki S, Lin SM. 2017. Acoustic differentiation and behavioral response reveal cryptic species with *Buergeria* treefrogs (Anura, Rhacophoridae) from Taiwan. *PLOS ONE* 12(9): e0184005.

DOI: https://doi.org./10.53716/jtc.3.1.8.2022
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Received: 29 April 2022
Published: 30 July 2022
www.jtcoleop.com

Wang YH, Hsiao YW, Lee KH, Tseng HY, Lin YP, Komaki S, Lin SM. 2020. Renaming a new *Buergeria* species from Taiwan – correction of a nomenclatural act not available to ICZN. *Nature Conservation Quarterly* 111: 4-13.

Wiesner J. 2020. *Checklist of the Tiger Beetles of the World, 2nd Edition.* 540 pp. Winterwork, Borsdorf.

DOI: https://doi.org./10.53716/jtc.3.1.8.2022
ZOOBANK: https://zoobank.org/References/345DA4D2-7746-43BB-A5CD-8B6737BDFF08
Received: 29 April 2022
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