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Research

Revisionary Notes on the Stag Beetle Genus *Lucanus* scopoli, 1763 (Coleoptera: Lucanidae) in Taiwan, with New Records and Nomenclatural Changes

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Abstract

This study presents significant taxonomic updates for stag beetles of the genus *Lucanus* in Taiwan. The author reports a new locality record for *Lucanus yulaoensis* Lin, 2021 and proposes *Lucanus kurosawai* Sakaino, 1995 as a new junior synonym of *Lucanus chuyunshanus* Sakaino & Yu, 1993 **(stat. nov.)**. Furthermore, the study reinstates the species status of *Lucanus ogakii* Imanishi, 1990 **(stat. rev.)**. An updated checklist including all eleven currently recognized Taiwanese *Lucanus* species and subspecies is provided.

Keywords: *Lucanus*, new record, synonym, taxonomic revision, Taiwan.

Introduction

The genus *Lucanus* Scopoli, 1763 represents one of the most diverse groups of stag beetles (Lucanidae), comprising approximately 123 species worldwide (GBIF, 2025). In Taiwan, this genus includes 11 recognized taxa (species and subspecies), though their classification remains problematic due to historical inconsistencies and limited morphological comparisons. Recent studies combining molecular phylogenetics and detailed morphological examinations have begun resolving these issues, yet critical taxonomic ambiguities persist.

For instance, *L. yulaoensis* was initially described based on distinct morphology and geographic isolation, with subsequent molecular analyses confirming its validity (Chou et al., 2021). Genomic evidence further supports its species status, showing deep divergence (~650,000 years) from related taxa like *L. miwai* (Mattia et al., 2023). Similarly, *L. ogakii* has undergone conflicting taxonomic interpretations—initially recognized as a valid species (Imanishi, 1990),

later relegated to a subspecies (Huang & Chen, 2010), and finally reaffirmed as distinct through multilocus phylogenetics (Tsai & Yeh, 2016).

Additionally, *L. masumotoi chuyunshanus* Sakaino & Yu, 1993 exemplifies unresolved complexities. Described from a single male without genitalia dissection, its validity was questioned due to inaccessible type material and misassignments of populations (e.g., Taitung specimens erroneously linked to this taxon).

Such issues highlight the need for comprehensive revisions integrating type specimen reevaluations, molecular data, and biogeographic evidence.

Materials & Methods

All specimens examined in this study were obtained through legal means. For specimens located within national parks or protected areas, documentation was conducted exclusively through photographic records. Specimens collected prior to the establishment of current conservation regulations were included in morphological analyses. Genitalia dissection was performed as a primary diagnostic method for species identification.

Taxonomic identification was based on comprehensive comparisons with contemporary literature on stag beetle systematics (Tsai & Yeh, 2016; Huang & Chen, 2010; Sakaino & Yu, 1993). Voucher specimens have been deposited in the following collections:

JZLC Private collection of Jing-Zhi Lin, Taipei, Taiwan

MSMT Muh Sheng Museum of Entomology collection, Taiwan

Results

Taxonomic Treatments

Family Lucanidae Latreille, 1804

Tribe Lucanini Latreille, 1804

Genus *Lucanus* scopoli, 1763

Lucanus yulaoensis Lin, 2021 (Fig. 1-2)

Lucanus yulaoensis Lin, 2021: 1–5; Fig. for♂holotype; Chou et al., 2021: 745-759; Mattia et al., 2023: 853-869. co1 data, nuclear sequence data; Zhan &Young, 2023:329, (Figs 171–176, 267, 299, 430–432) for habitus and genitalia. Chang, 2024: 52-53, 151-152 discussion on species.

Distribution. Taiwan: Hsinchu, Miaoli (Xueshan Range, 1400-1800m)

Photo records. 1♂ 1♀ Mt. Nan-keng, 1800m Miaoli County, Shei-Pa National Park; the photo taken by Wu Chien-Te on May 2021.

Figure 1-2. A living individual of *Lucanus yulaoensis* Lin, 2021 from Mt. Nankeng, Miaoli County, Shei-Pa National Park; the photo taken by Wu Chien-Te on May 2021.

Remark. Following the taxonomic framework proposed by Zhan et al. (2023), this species should be classified within the *L. brivioi* species group. Considering the current distribution pattern (Hsinchu, Miaoli) and habitat continuity along the Snow Mountain Range, combined with analyses of species dispersal capability, this study predicts the likely existence of undiscovered isolated populations in the Xueshan Range. This hypothesis warrants verification through future field surveys, with particular focus on undisturbed broadleaf forest zones at elevations of 1400-1,800 m.

Lucanus ogakii Imanishi, 1990 stat. rev. (Fig. 5-6, 9-10, 13-14, 17-18, 21, 24)

Lucanus ogakii Imanishi, 1990; 15, figs. 1, 2-1a for male holotype, fig. 2-16 for male paratype, figs. 3-1, 3-2 for male genitalia, Piru, Hualian Pref., Formosa; Mizunuma & Nagai, 1994: 214, pl. 12, figs. for male, female and natural history. 101-1-101-4 for males, fig. 101-5 for female, all from Pilu, Hualien, Taiwan, Chang, 2006: 48-49, 2024:46-47 figs.

= *Lucanus masumotoi* Hirasawa & Akiyama, 1990: 55, pl. 5, figs. 9, 10 for male, fig. 11 for female, pl. 6, figs 14, 16 for male, between Pilu Shenmu, Hualien, Taiwan, Mizunuma & Nagai, 1994, 214 (Synonymised by Mizunuma & Nagai, 1994).

Lucanus masumotoi masumotoi: Sakaino & Yu, 1993: 15, figs. 9-10 for male.

Lucanus kanoi ogakii: Huang & Chen 2010; 129-132. for habitus and genitalia.

Type material. Taiwan: 3♂♂(JZLC), Hualien County, Guan-yuan, 2374 m, V1.1982, collector not recorded; 4♂♂1♀(JZLC), Hualien County, Pilu 2150m, 15. V1.1984, local collector leg.; 5♂♂3♀♀(JZLC), Taitung County, Hai-duan, Xiang-yang, 2320 m, 30.V1.2023,

J-Z Lin, leg.

Distribution. Taiwan: Hualien, Taitung, Pingtung (Central Mountain Range, 1800-2300 m)

Taxonomic Notes. *Lucanus ogakii* was originally established as a valid species by Imanishi (1990), a taxonomic status consistently supported by subsequent taxonomic revisions (Mizunuma & Nagai, 1994; Chang, 2006, 2024; Fujita, 2010). Huang & Chen (2010) proposed its subspecific status under *L. kanoi* based on perceived insufficient morphological differentiation. This reclassification was challenged by Tsai & Yeh (2016) through comprehensive molecular phylogenetic analysis utilizing 240 sequences (COI+16S+28S rDNA), which provided robust evidence for its specific distinctiveness.

The present study corroborates these findings through detailed morphological comparisons, identifying two novel diagnostic characters: 1) Slender cephalic process of the paramere (contrasting with the stout morphology in *L. kanoi*); 2) Reduced frontal ridge development associated with a shortened clypeolabrum.

Integrating this new morphological evidence with existing molecular data, this study formally reinstates *Lucanus ogakii* Imanishi, 1990 as a full species (status reviviscens), resolving its longstanding taxonomic ambiguity.

***Lucanus chuyunshanus* Sakaino & Yu, 1993 stat. nov. (Fig. 3-4, 7-8, 11-12, 15-16, 19, 20, 23)**

= *Lucamus kurosawai* Sakaino, 1995: 6, figs. 2a, 3a, 4a, pl. 2, figs. 1-5 for males, fig. 5 for male genitalia, holotype male, Sungkang, Nantou Hsien, Taiwan; Chang, 2006:50-51,2024:48-49; Huang & Chen, 2010:128-129. syn. nov.

Lucanus masumotoi chuyunshanmus Sakaino & Yu, 1993: 15, figs:7-8 for male holotype, Mt. Chuyunshan, Kaohsiung, Taiwan.

Lucanus ogaki chuyunshanus: Mizunuma & Nagai, 1994: 122; Chang, 2006: 49; Huang & Chen,2010:130 discussion on subspecies.

Type material. Taiwan: 2♂♂ (JZLC) Chuyunshan lindao, Kaohsiung-Hsien, Taiwan, 18. VI. 1991, collector not recorded.1♂1♀ (JZLC), Nantou County, Ren'ai, Songgang-Cuifeng, 2300 m, 10.V.2018, local collector leg. 2♂♂, 1♀ (JZLC), Yilan County, Datong Township, 2000 m 07.V1.2025, local collector leg.4♂♂1♀ (JZLC), Chiayi County, Alishan,2350m, V.2021, J-Z Lin, leg.

Distribution. Taiwan: Hsinchu, Miaoli, Taichung, Nantou, Chiayi, Kaohsiung, Yilan **(new record)** (2000-2500 m).

Taxonomic Notes. Sakaino and Yu (1993) originally established the new subspecies *Lucanus masumotoi chuyunshanus* based solely on external morphological characteristics of a single male specimen collected from Mt. Chuyunshan in Kaohsiung, without genitalia dissection. Subsequent typhoon-induced road damage at the type locality prevented additional specimen

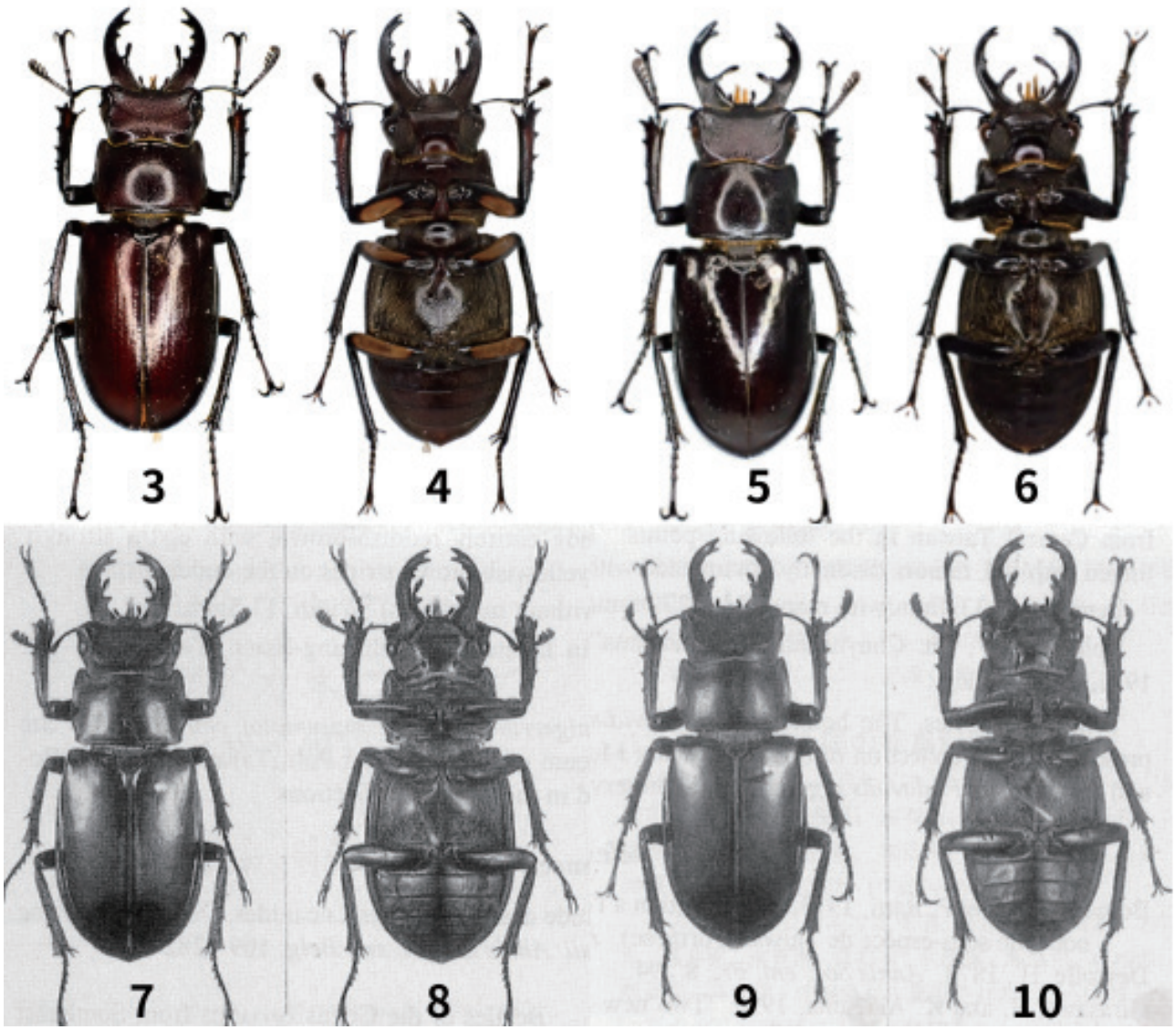

Figure 3-10. Habitus photographs of Taiwanese *Lucanus* species.3-4: Topotypic specimens of *L. chuyunshanus* 7-8: Male holotype of *L. chuyunshanus* (reproduced from Sakaino & Yu, 1993), 5-6: Topotypic specimens of *L. ogakii*, 9-10: Comparative specimens of *L. ogakii* (after Sakaino & Yu, 1993).

collection for an extended period, leading to persistent doubts regarding the subspecies' taxonomic validity (Chang, 2006, 2024; Huang & Chen, 2010). Notably, none of these researchers examined either holotype or topotypic specimens for verification. Despite these reservations, no systematic taxonomic revision was conducted. A significant taxonomic discrepancy emerged when Chang (2006) and Tsai and Yeh (2016) identified populations of *L. ogakii* from Xiangyang in Taitung as belonging to this subspecies. This determination fundamentally contradicts the original description, which explicitly designated the subspecies' distribution as being in Kaohsiung County of southwestern Taiwan, not southeastern Taitung. This geographical misassignment further compounded the taxonomic confusion surrounding this group.

This comparative examination of the original holotype imagery and topotypic specimens demonstrates that the Mt. Chuyunshan population exhibits diagnostic morphological features inconsistent with *L. ogakii* but concordant with *L. kurosawai*. Key phenotypic differentiae

Figure 11-12. Male genitalia of *L. chuyunshanus*. 11: aedeagus dorsal, 12: lateral.

include: (1) disproportionate mandibular fork length (inner > outer), (2) acutely angled pronotal inferior margins (contrasting with the rounded profile in *L. ogakii*), (3) pronounced frontal cephalic angles (versus reduced development in *L. ogakii*), (4) distinctive yellowish-brown ventral femoral patterning, and (5) significantly denser and longer ventral pubescence compared to *L. ogakii*.

Genitalic morphology provides additional diagnostic support: the basal piece exhibits an obsolete ventral plate with profound medial concavity that does not extend beyond its caudal margin, while the parameral cephalic process presents a robust dorsal profile (distinctly broader than the slender configuration characteristic of *L. ogakii*).

The material examined conforms rigorously to the original description of ssp. *chuyunshanus* : "integument uniformly reddish-brown with vivid ventral erythrism; femora displaying well-defined yellowish-brown striping on ventral surfaces." Notably, the Kaohsiung population manifests phenotypic divergence through darker pigmentation, enhanced cuticular reflectance,

Figure 13-14. Male genitalia of *L. ogakii*. 13: aedeagus dorsal, 14: lateral.

and reduced setal density relative to typical *L. kurosawai*.

This unique combination of melanism, surface gloss, and pubescence reduction likely precipitated the initial misassignment of southern specimens to *L. ogakii* by Sakaino and Yu (1993). Based on the integrated morphological evidence presented herein, this study formally elevates the ssp. *chuyunshanus* to full species rank as: *L. chuyunshanus* Sakaino & Yu, 1993 stat. nov.

In compliance with Article 23 of the International Code of Zoological Nomenclature (ICZN, 1999), this study formally proposes *L. kurosawai* Sakaino, 1995 as a new junior synonym (syn. nov.) of *L. chuyunshanus* Sakaino & Yu, 1993.

Remark. The original description of this subspecies by Sakaino and Yu (1993) was based on a single male specimen, with the holotype reportedly deposited in the Muh Sheng Museum of Entomology (MSMT). However, examination of the museum collection failed to locate the holotype. As both original authors are deceased (the specimen is presumed to remain in co-

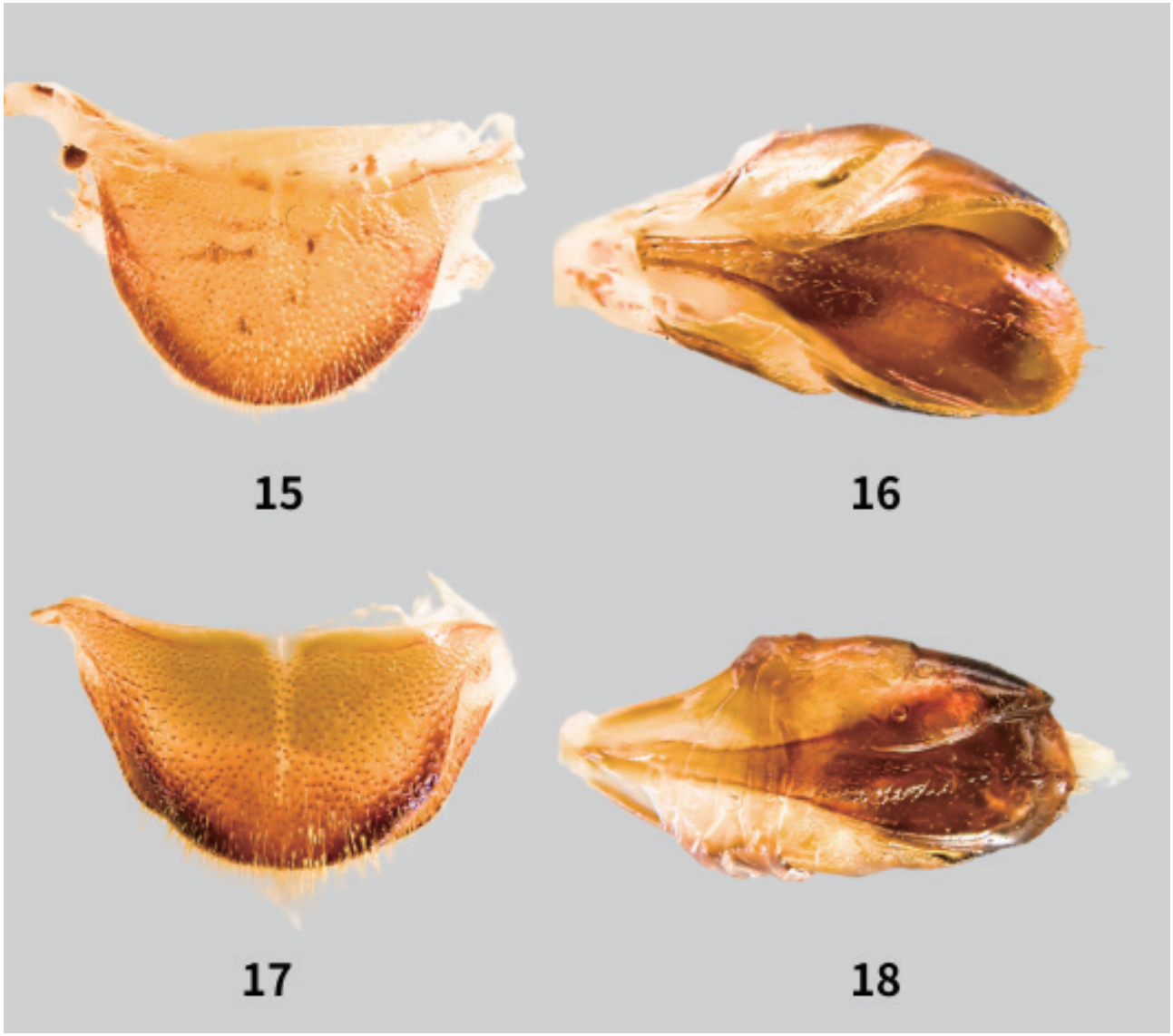

Figure 15-18. Male abdominal segments VIII & IX in dorsal. 15-16: *L. chuyunshanus*. 17-18: *L. ogakii*.

author Mr. Yu's private collection), attempts were made to contact Mr. Yu's family in Puli regarding the specimen's whereabouts, but these efforts proved unsuccessful. A significant development occurred when part of Mr. Yu's collection was transferred to Taipei by his relatives. Examination of these materials revealed the holotype of another new subspecies (*Primognathus davidis nigerrimus* Sakaino et Yu, 1993) described in the same publication.

Although the holotype of *L. chuyunshanus* remains missing, two additional specimens matching the original type locality were discovered, permitting genitalia dissection and morphological re-examination.

While this study refrains from formally declaring the holotype lost (as it may exist in undiscovered portions of Mr. Yu's collection), these specimens would qualify for neotype designation should the holotype's permanent absence be confirmed.

The present study adopts a conservative taxonomic approach. As the holotype might still exist in undiscovered portions of Mr. Yu's collection, definitive conclusions regarding its status are

drawn. However, the available specimens provide sufficient morphological evidence for reliable taxon identification. Should the holotype be confirmed lost, neotype designation based on existing specimens will be proposed, following ICZN guidelines to maintain nomenclatural stability for this taxonomic unit.

A checklist of described *Lucanus* species and subspecies from Taiwan

These records are based on Huang and Chen (2010), Fujita (2010), Chang (2006), Wang & Ko (2018), Liu (2019) and the author of the present study.

I. The *L. fortunei* group

Lucanus swinhoei Parry, 1874

Chinese common name:姬深山鍬形蟲

Distribution: The altitude of Taiwan 200-1800 m

Lucanus datunensis Hashimoto, 1984

Chinese common name:大屯姬深山鍬形蟲

Distribution: Taipe Datunshan 800-1000 m

Lucanus chengyuani Wang & Ko, 2018

Chinese common name:承遠深山鍬形蟲

Distribution: Alishan, Chiayi County

II. The *L. maculifemoratus* group

Lucanus ogakii Imanishi, 1990

Chinese common name:黑腳深山鍬形蟲

Distribution: Hualien, Taitung, Pingtung (Central Mountain Range 1800-2300 m)

Lucanus dybowski taiwanus Miwa, 1936.

Chinese common name:高砂深山鍬形蟲

Distribution: The altitude of Taiwan 1200-2500 m

Lucanus chuyunshanus Sakaino et Yu, 1993

Chinese common name:毛栗色深山鍬形蟲

Distribution: Hsinchu, Miaoli, Taichung, Nantou, Chiayi, Kaohsiung, Yilan (2000-2500 m)

Lucanus kanoi Kurosawa, 1966

Chinese common name:栗色深山鍬形蟲

Distribution: Nantou, Taichung 1600-2100 m

Lucanus kanoi piceus Kurosawa, 1966

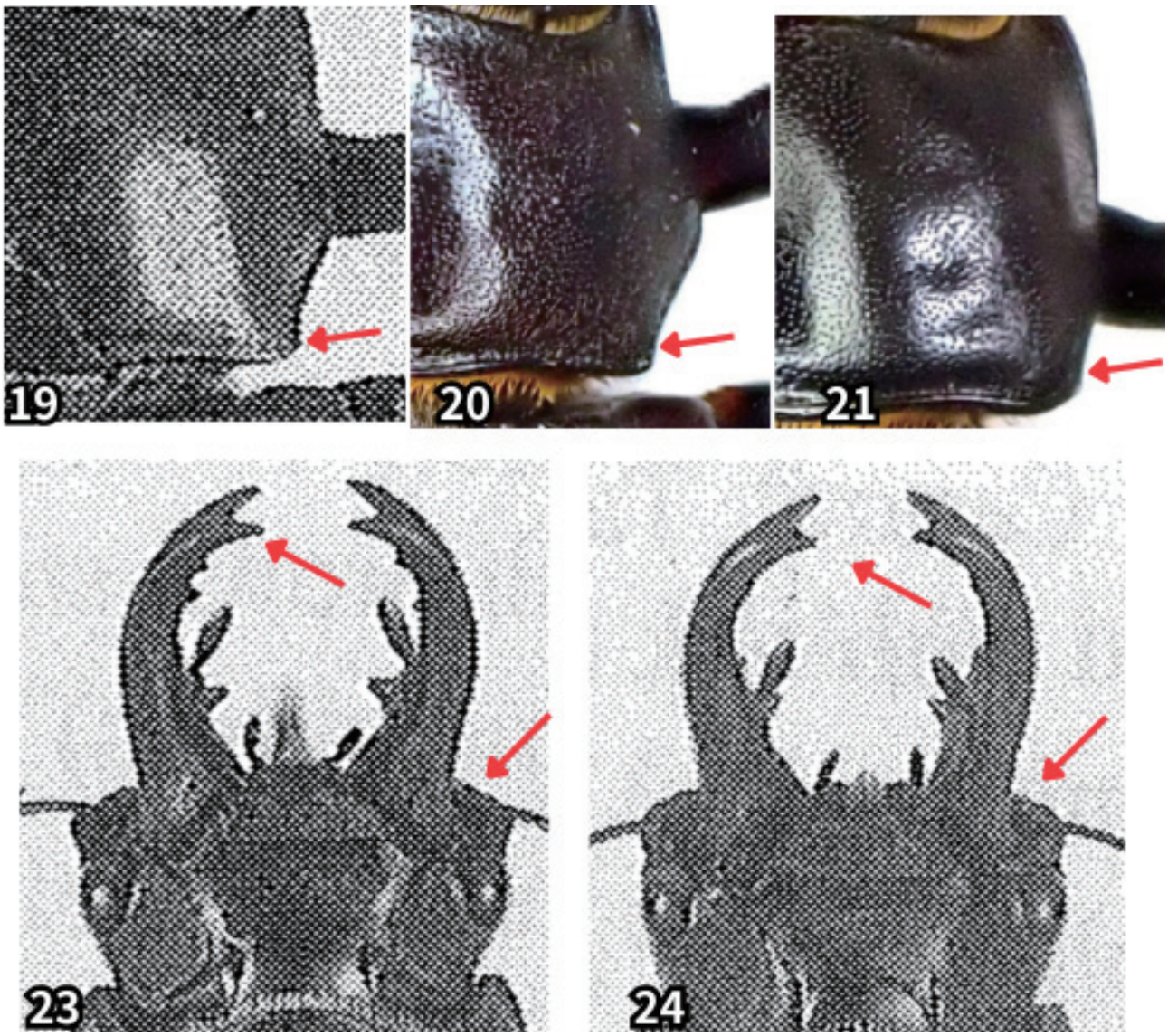

Figure 19-24. Head, pronotum of male in dorsal view and ventral. 19, 23: Male holotype of *L. chuyunshanus* (after from Sakaino & Yu, 1993). 20: Topotypic specimens of *L. chuyunshanus* 21: Topotypic specimens of *L. ogakii*, 24: Comparative specimens of *L. ogakii* (after Sakaino & Yu, 1993),

Chinese common name:黑栗色深山鍬形蟲

Distribution: Taoyuan, Hsinchu, Yilan, New Taipei City 1600-2100 m

III. The *L. brivioi* group

Lucanus miwai Kurosawa, 1966

Chinese common name:黃腳深山鍬形蟲

Distribution: Taichung, Nantou Central Mountain Range 1800-2300 m

Lucanus yulaoensis Lin, 2021

Chinese common name:宇老深山鍬形蟲

Distribution: Hsinchu, Miaoli Xueshan Range1400-1800 m

IV. The *L. laminifer* group

Lucanus formosanus Planet, 1899

Chinese common name:臺灣深山鍬形蟲

Distribution: The altitude of Taiwan 500-1800 m

Discussion

The taxonomic status of several Taiwanese *Lucanus* taxa remains contested, reflecting broader challenges in stag beetle systematics. *L. dybowski taiwanus* Miwa, 1936 exemplifies this complexity. Originally described as a distinct species (*L. taiwanus*), its classification has fluctuated significantly: Huang and Chen (2010) demoted it to a subspecies of *L. dybowski* based on genital morphology, while Wang and Ko (2018) subsequently reinstated its species status without substantive justification. Chang's (2024) support for species recognition similarly lacked evidentiary support, creating taxonomic ambiguity. However, Liu's (2019) comprehensive phylogenetic analysis provides compelling molecular evidence for maintaining its subspecific status under *L. dybowski*, a conclusion adopted in the present study.

Similar controversy surrounds *L. kanoi piceus*. While Chang (2006, 2024) questioned its validity without presenting counterevidence, multiple independent studies support its recognition. Huang and Chen (2010) documented stable diagnostic differences in clypeolabrum morphology between subspecies, and Tsai and Yeh (2016) provided robust phylogenetic support for its distinctiveness. This convergence of morphological and molecular evidence strongly supports retaining *L. kanoi piceus* as a valid subspecies.

These case studies underscore three critical issues in Taiwanese stag beetle taxonomy: (1) the persistent gap between morphological and molecular systematic approaches, (2) the problematic practice of taxonomic revisions without sufficient evidentiary support, and (3) the need for integrated analyses incorporating both traditional and modern techniques. The dynamic nature of *Lucanus* systematics in Taiwan reflects the archipelago's complex biogeographic history, where geographic isolation has promoted rapid diversification. This revision synthesizes these disparate lines of evidence to stabilize classification while explicitly identifying areas requiring further research, particularly genomic studies to resolve remaining uncertainties in species boundaries.

Competing interests

The authors declared that no competing interest exists in the preparation of the manuscript.

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