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Research Article

Redescription of *Gastrophysa atrocyanea* (Motschulsky) and *G. polygoni* (Linnaeus) (Insecta: Coleoptera: Chrysomelidae: Chrysomelinae), with Notes on Their Biology

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Abstract

Lee, C. F. 2022. Redescription of *Gastrophysa atrocyanea* (Motschulsky) and *G. polygoni* (Linnaeus) (Insecta: Coleoptera: Chrysomelidae: Chrysomelinae), with notes on their biology. J. Taiwan Agric. Res. 71(4):281–292.

Gastrophysa atrocyanea (Motschulsky, 1860) is a Chrysomelinae species that appears only during spring, with only one record reported from Taiwan. More specimens were collected from Kinmen islands. This species was redescribed, based on morphological characteristics, including the penis, gonocoxae, spermatheca, and abdominal ventrite VIII in females. Another widespread species, *G. polygoni* (Linnaeus), was compared to test the diagnostic value of these characters. Detailed biological information is provided for *G. atrocyanea*, including larval and adult feeding behaviors, host plants, and life cycle. *G. polygoni elongata* Jolivet 1951 is proposed as a junior synonym of the nominate subspecies.

Key words: Leaf beetles, Taxonomy, Polygonaceae, *Rumex nipponicus*, *Rumex crispus*.

INTRODUCTION

Gastrophysa Chevrolat, 1836 is a small chrysomeline genus containing seven species in the Palaearctic region (Kippenberg 2010). It can be recognized from other chrysomeline genera by combination of the following characters: anterior coxal cavities open posteriorly, simple tarsal claws, interior margin of elytral epipleuron lacking setae, and elytral punctures randomly arranged. The genus is also characterized by the angular tibial apex (Fig. 13) bearing a slender, flattened process along the interior margin (Fig. 14).

Gastrophysa atrocyanea (Motschulsky, 1860) was first recorded from Taiwan by Jolivet (1951) when he revised this genus. No additional specimens were mentioned in Chûjô's revision of Taiwanese Chrysomelinae (Chûjô 1958). Chang (2017) recorded this species from Liehyu Island (烈嶼), one of the Kinmen Islands. A series of adults were collected from leaves of *Rumex nipponicus* on Kinmen Island by Mr. Wei-Ting Liu in April 2008. He is a member of the Taiwan Chrysomelid Research Team, which is composed of ten members and has been inventorying all leaf beetles in Taiwan since 2005. I found substantial populations of this species on *Rumex nipponicus* during early March 2022. I here redescribe this species and describe diagnostic characters which were missed by previous studies. The diagnostic value of other genitalic characters were evaluated by comparisons with those of another widespread congener, *G. polygoni* (Linnaeus). Biological information is noted specially for populations in the Kinmen Islands.

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MATERIALS AND METHODS

For rearing studies, larvae were placed in a small glass containers (diameter 142 mm × height 50 mm) with cuttings from their host plants. When mature larvae began to search for pupation sites, they were transferred to a smaller plastic containers (diameter 90 mm × height 57 mm) filled with moist soil, the amount about 80% of container volume.

For delimiting variability of diagnostic characters, at least one pair from each locality was examined. Length was measured from the anterior margin of the eye to the elytral apex, and width at the greatest width of the elytra. All voucher specimens were deposited at the Applied Zoology Division, Taiwan Agricultural Research Institute (TARI), Taichung, Taiwan.

RESULTS

Gastrophysa atrocyanea Motschulsky, 1860

Gastrophysa atrocyanea Motschulsky, 1860: 222 (Russia: East Siberia); Baly 1874: 175 (Japan, Northern China); Marseul 1878: 142 (redescription; East Siberia); Lewis 1879: 28 (catalogue; Japan); Jacoby 1885: 754 (catalogue; Japan); Marseul 1888: 371 (key, redescription); Jolivet 1951: 14 (revision); Chûjô 1958: 19 (redescription of Taiwanese species); Chûjô and Kimoto 1961: 152 (catalogue; host plants); Gressitt and Kimoto 1963: 340 (China: Fujian, Gansu, Hunan, Liaoning); Kimoto 1964: 270 (Japan: Kyushu, Honshu); Kippenberg 2010: 393 (China: Hebei, Jiangxi; Russia: Far East); Yang *et al*. 2015: 29 (China: Heilongjiang, Inner Mongolia, Shaanxi, Qinghai, Shanghai, Anhui, Yunnan).

Gastroidea atrocyanea: Horald 1874: 3403 (catalogue); Schönfeldt 1887: 181 (catalogue; Japan); Chen 1934: 52 (redescription; China: Beijing, Hubei, Jiangsu, Sichuan, Zhejiang; Vietnam); Chen 1936: 164 (redescription); Chûjô 1940: 80 (Japan: Shikoku); Chûjô 1941: 72 (Korea).

Gastroidea tonkinea Achard, 1923: 134 (Vietnam). Synonymized with *G. atrocyanea* by Chen (1934).

Specimens examined. CHINA. Heilongjiang: 1 ex., Yu-chuan, Harbin (= Ping-Kiang Prov.), 25-28.VI.1938, leg. M. Nikitin; Hubei: 1 ex., Mts. Wu-schan; Zhejiang: 1 ex., Hangchow (杭州), 19.III.1933, leg. C. C. Tao; **JAPAN.** Honshu: 1 ex., Ikeda, Osaka, 18.V.1932, leg. K. Iwata; 1 ex., same but with “10.VI.1932”; 1 ex., Yokohama, 15.V.1880, leg. G. Lewis; Kyushu: 2 exs., Mt. Korasan, Chikugo, 7.IV.1934, leg. K. Yamauchi; 1 ex., Mozi, 10.VI.1940, leg. N. Mori; Shikoku: 2 exs., Kochi-ken, 19.V.1935, leg. I. Okubo; **SOUTH KOREA**: 1 ex., Kankyo Nando, Hokusei gun, 3.VIII.1937, leg. M. Yamada; 1 ex., Keikidô, Suigen (= Suwon), 3.VI.1933, leg. D. Okamoto; **TAIWAN.** Kinmen: 34 exs., Jinhu (金湖), 30.IV.2008, leg. W.-T. Liu; 3 exs., Jincheng (金城), 9.III.2022, leg. C.-F. Lee; 9 exs., Lieyu (烈嶼), 16.IV.2015, leg. Y.-J. Chang; 5 exs., same but with “19.IV.2015”; 15 exs., same but with “24.IV.2016”.

Redescription. Length 5.5–6.1 mm, width 2.7–3.5 mm. General color (Figs. 1–3) dark metallic purple, except apex of abdominal ventrite V yellow. Antennomeres II–VI filiform in males, VII–X moniliform, XI lanceolate (Fig. 7), ratios of lengths of antennomeres I to XI 1.0 : 0.7 : 0.7 : 0.8 : 0.6 : 0.6 : 0.6 : 0.6 : 0.6 : 0.6 : 1.1; ratios of length to width from antennomeres I to XI 2.0 : 1.9 : 2.3 : 2.2 : 1.8 : 1.4 : 1.2 : 1.1 : 1.1 : 1.1 : 2.1; similar in females (Fig. 8), ratios of lengths of antennomeres I to XI 1.0 : 0.6 : 0.8 : 0.7 : 0.5 : 0.5 : 0.5 : 0.6 : 0.5 : 0.5 : 0.9; ratios of length to width from antennomeres I to XI 2.2 : 1.9 : 2.5 : 2.3 : 1.7 : 1.3 : 1.2 : 1.3 : 1.1 : 1.2 : 2.1. Pronotum 1.5–1.6 times wider than long; disc with dense, coarse punctures, lateral margins slightly rounded, widest above middle; apical margins slightly concave and basal margin slightly convex at middle. Elytra 1.4–1.5 times longer than wide; disc with dense, coarse punctures; parallel-sided, apices rounded. Aedeagus (Fig. 9, 10) extremely broad, about 2.8 times longer than wide; parallel-sided; subapically narrowed, apex widely rounded; moderately curved in lateral view; tectum well sclerotized and short, apical margin slightly depressed at middle; endophallic sclerites composed of three parts: (1) a pair of lateral sclerites connected to each oth-

er, with one transverse sclerite near apex, short and longitudinal; (2) one medial sclerite, basally broader; and (3) one curved sclerite ventrally concealed at middle. Gonocoxae (Fig. 15) longitudinal and separated; each gonocoxa basally narrowed and apex widely rounded, with dense short setae at apical area. Ventrite VIII (Fig. 11) with apex weakly sclerotized, dense short setae along apical areas; apical margin with deep furrow at middle. Spermathecal receptaculum (Fig. 12) slender, not separated from pump; pump long and curved; sclerotized spermathecal duct extremely long, with base wide.

Variation. Adults of Japanese populations are much yellow on the abdomen, including entire ventrite V and apex of ventrite IV.

Diagnosis. Adults of *Gastrophysa atrocyanea* can be recognized by their color pattern: entire body dark metallic blue (Figs. 1–3) [yellow dorsum, black scutellum and suture of elytra in *G. mannerheimi* (Stål); greenish-blue body, yellowish-brown pronotum, bases of antennae and legs in *G. polyoni* (Linnaeus) (Figs. 4–6); metallic green body, dark green legs and antennae in *G. viridula* (DeGeer)]. In genitalic characters, *G. atrocyanea* differs from *G. polygoni* by lacking a longitudinal groove at the apex of the aedeagus, shorter tectum, and longitudinal lateral sclerites of the internal sac (Figs. 9, 10) [short longitudinal groove at apex of aedeagus, longer tectum, and curved lateral sclerites of internal sac in *G. polygoni* (Figs. 26, 27)]; basally narrow gonocoxae (Fig. 15) [wider basal half of gonocoxae in *G. polygoni* (Fig. 30)]; and deep furrow at middle of apical margin of abdominal ventrite VIII in females (Fig. 11) [shallow furrow at middle of apical margin of abdominal ventrite VIII in females of *G. polygoni* (Fig. 28)].

Host plants. Leaves of *Polygonum aviculare*, *Persicaria maculosa* (= *Polygonum persicaria*), *Rumex acetosa*, *R. conglomeratus*, *R. japonicus*, *R. longifolius*, *R. madaio* (Polygonaceae), and *Stellaria aquatica* (Caryophyllaceae) (Chûjô & Kimoto 1961). Naito *et al*. (1979) tested the host specificity of this species and found that *Rumex obtusifolius* was the most favorable food plant. In addition, certain species of *Polygonum*, such as *P. persicaria* and *P. filiforme* also proved favorable. Xiaoshui (1991) also tested the host specificity, and found that both larvae and adults fed on *R. japonicus* and *R. acetosa* while the former was favored. Larvae also fed on two *Polygonum* species, *P. hydropiper* and *P. perfoliatum*. But adults were not found on these two species. In Kinmen Island populations, larvae and adults fed on leaves of *R. nipponicus*, but adults were only found feeding on leaves of *R. crispus*.

Biological notes. This species is univoltine. In Japan, overwintered adults begin to oviposit in early spring. Larvae are most abundant in late April and early May. Newly emerged adults feed for some 10 d before they enter into the soil in middle June to rest until the following spring (Miyazaki 1979). In China, adults were observed copulating and laying eggs in early March. Each female laid 725–1156 eggs. The eggs were deposited on the undersurfaces of leaves in batches of about 34. Incubation lasted 9−10 d. Young larvae were gregarious on leaves. The larvae passed through three instars for a total of 16−20 d. Mature larvae left the plant and tunneled into moist soil to pupate underground. Adults emerged after 7−9 d. In the field they consumed some older leaves of remaining *R. japonicus* for a short period of time, and then disappeared from the host until the following year (Xiaoshui 1991).

In Taiwan, *Rumex nipponicus* was observed seriously defoliated caused by *Gastrophysa atrocyanea* (Figs. 16) on March 9, 2022, at Jincheng (金城) township, Kinmen islands. Eggs (Fig. 18), larvae (Fig. 19) and adults (Fig. 21) were found on leaves. Larvae grazed on undersides of leaves (Fig. 17). All adults went into resting period in a few days. Mature larvae (Fig. 19) burrowed into the soil for pupation. The pupal stage (Fig. 20) lasted 4 d only at room temperature (18℃). Newly emerged adults fed on plant leaves for 3 d then entered their resting phase. April 13, 2022, the plant of *Rumex nipponicus* were found almost dead when I visited again after one month later. No individuals of *G. atrocyanea* were present on plants. During that visit, I found some adults feeding on leaves of *R. crispus* (Figs. 22, 23) at Jinhu (金湖) township. It appeared

that only the adults were feeding based on the shape of the feeding damage (Figs. 23).

Distribution. China, Japan, Korea, Russia, Taiwan, Vietnam.

Gastrophysa polygoni (Linnaeus, 1758)

Chrysomela polygoni Linnaeus, 1758: 370 (Europe).

Gastrophysa polygoni: Chevrolat 1836: 405; Jolivet 1951: 10 (revision).

Gastroeidea polygoni: Hope 1840: 164; Chen 1936: 164 (China: Beijing); Chûjô 1941: 73 (Korea); Chûjô 1942: 59 (China: Guandong).

Chrysomela ruficollis Fabricius, 1775: 820 (England). Regarded as an abnormal form of *G. polygoni* by Jolivet (1951).

Chrysomela obtusa Müller, 1776: 82. Regarded as an abnormal form of *G. polygoni* by Jolivet (1951).

Chrysomela caeruleipennis Say, 1825: 296 (United States). Synonymized with *G. polygoni* by Harris (1842).

Phaedon rubripes Philippi and Philippi, 1864: 390 (Chile, mislabeled). Synonymized with *G. polygoni* by Askevold (1991).

Gastrophysa polygoni elongata Jolivet, 1951: 13 (China). syn. nov.

Specimens examined. AUSTRIA. 2 exs., Neusidel. S., leg. Schuster; **CHINA.** Guandong. 4 exs., Ryosuiji, 23.VII.1936, leg. M. Hanano; 1 ex., same but with "26.VII.1939"; **FRANCE.** 7 exs., Foret de Fougere, Ille et Vilaine, 30.VII.1937, leg. C. Bourveau; **GERMANY.** 1 ex., Siegmündung, 3.VII.19??; **NORTH KOREA.** 1 ex., Naiso, Mt. Myoko, Heian-Hokudo, 29.VII.1937, leg. T. Kusanagi; 1 ex., Gonei, Mt. Myoko, Heian-Hokudo, 31.VII.1937, leg. T. Kusanagi; 1 ex., same locality, 31.VII.937, leg. M. Yamada; 1 ex., Kokai, Koaki-Gun, Heian-Hokudo, 18.VIII.1936, leg. M. Yamada; **ROMANIA.** 1 ex., Siebenbürgen, leg. Schuster.

Redescription. Length 4.7–5.4 mm, width 2.6–3.0 mm. General color (Figs. 4–6) metallic green, but prothorax and legs yellow, except tarsi blackish-brown, antennae black but four or five basal antennomeres yellowish-brown, apex of abdominal ventrite V yellow. Antennomeres II–VI filiform in males, VII–X moniliform, XI lanceolate (Fig. 24), ratios of lengths of antennomeres I to XI 1.0 : 0.6 : 0.7 : 0.6 : 0.6 : 0.6 : 0.7 : 0.7 : 0.7 : 0.6 : 1.1; ratios of length to width from antennomeres I to XI 2.6 : 1.8 : 2.1 : 1.9 : 1.6 : 1.5 : 1.6 : 1.6 : 1.5 : 1.3 : 2.3; similar in females (Fig. 25), ratios of lengths of antennomeres I to XI 1.0 : 0.6 : 0.7 : 0.6 : 0.6 : 0.6 : 0.6 : 0.6 : 0.6 : 0.6 : 1.0; ratios of length to width from antennomeres I to XI 2.4 : 1.7 : 2.1 : 1.9 : 1.9 : 1.5 : 1.5 : 1.5 : 1.5 : 1.3 : 2.3. Pronotum 1.7 times wider than long; disc with dense, coarse punctures, lateral margins slightly rounded, widest above middle; apical margins slightly concave and basal margin slightly convex at middle. Elytra 1.3−1.4 times longer than wide; disc with dense, coarse punctures; parallel-sided, apices rounded. Aedeagus (Fig. 26, 27) extremely wide, about 2.8 times longer than wide; parallel-sided; subapically narrowed, apex widely rounded; middle of apical margin with short longitudinal groove; moderately curved in lateral view; tectum well sclerotized and long, apical margin moderately depressed at middle; endophallic sclerites composed of three parts: (1) a pair of lateral elongate, strongly curved sclerites; (2) one medial sclerite basally widened; and (3) one curved sclerite concealed at middle. Gonocoxae (Fig. 30) longitudinal and separated, each gonocoxa widened at basal half and apex widely rounded, with dense, short setae apically. Ventrite VIII (Fig. 28) with apex weakly sclerotized, dense, short setae along apical areas; apical margin with shallow furrow at middle. Spermathecal receptaculum (Fig. 29) slender, not separated from pump; pump long and curved; sclerotized spermathecal duct extremely long, with base wide.

Diagnosis. Adults of *Gastrophysa polygoni* can be recognized by their color pattern: greenish-blue body, yellowish-brown pronotum and bases of antennae and legs (Figs. 4–6) [dark metallic blue body with yellowish-brown abdominal ventrite V in *G. atrocyanea* (Figs. 1–3); yellow dorsum, black scutellum and suture of elytra in *G. mannerheimi* (Stål); metallic green body, dark green legs and antennae in *G. viridula* (DeGeer)].

Genitalic characters of *G. polygoni* differ from those of *G. atrocyanea* by presence of short longitudinal groove near apex of aedeagus, with longer tectum, and curved lateral sclerites of internal sac (Figs. 26, 27) [lacking longitudinal groove at apex of aedeagus, with shorter tectum, and longitudinal lateral sclerites of internal sac in *G. polygoni* (Figs. 9, 10)]; widened basal half of gonocoxae (Fig. 30) [basally narrow gonocoxae in *G. polygoni* (Fig. 15)]; and shallow furrow at middle of apical margin of abdominal ventrite VIII in females (Fig. 28) [deep furrow at middle of apical margin of abdominal ventrite V in females of *G. polygoni* (Fig. 11)].

Notes. *Gastrophysa polygoni elongata* was described by Jolivet (1951) based on Chinese specimens. It is regarded as a junior synonym of the nominate subspecies since differences between both subspecies were not found based on material examined during this study.

Host plants. The true host plants of *G. polygoni* are limited to the plant family Polygonaceae, mainly in the genera *Polygonum*, *Fallopia*, and *Rumex*, although a considerable number of unrelated, secondary, or incidental hosts have been reported (LeSage & Majka 2009). In Europe, the preferred host is *Polygonum aviculare* and to a lesser extent *Fallopia convolvulus* (Sotherton 1982).

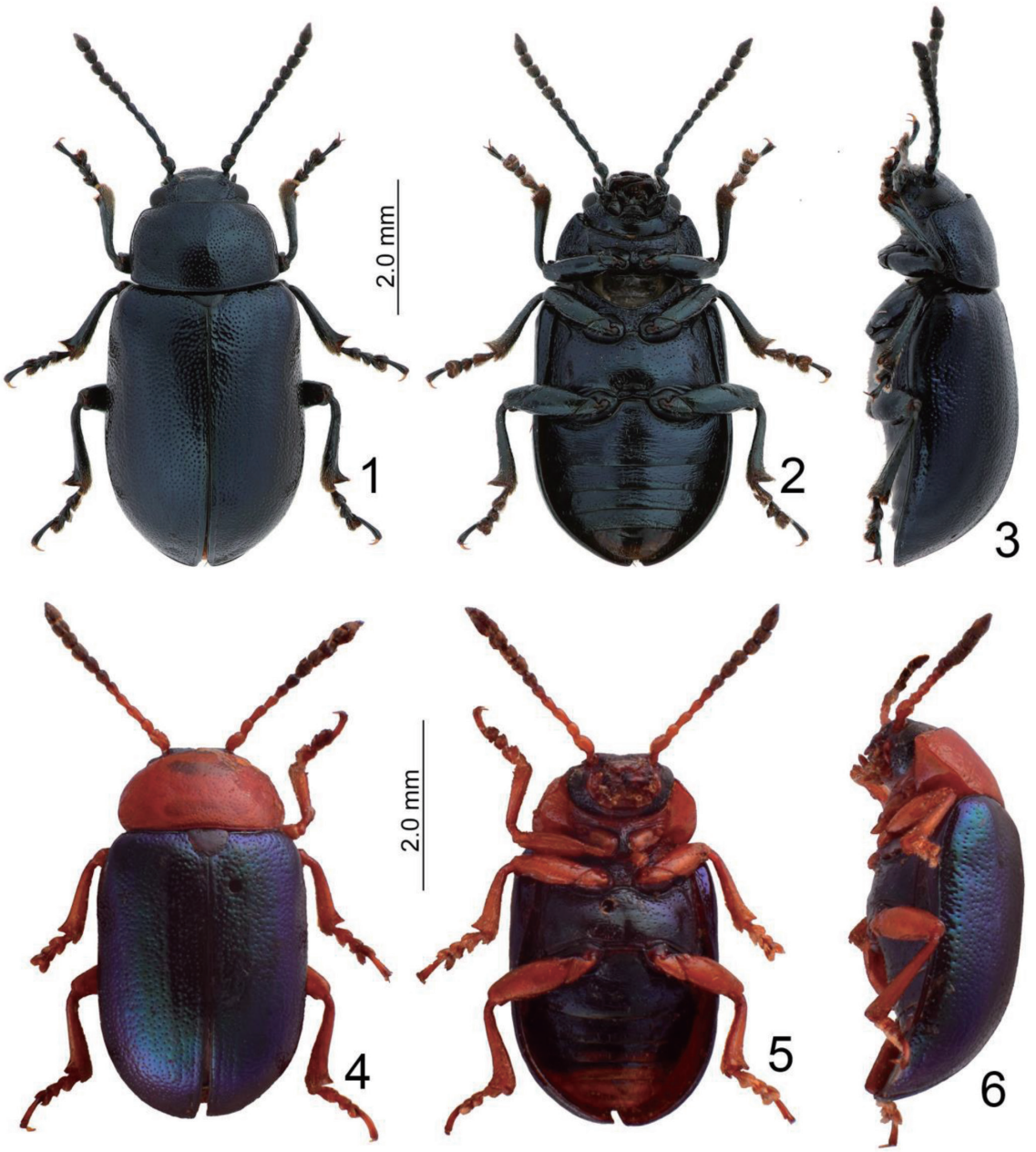
Biologcal notes. Overwintered adults leave their winter shelters in late April or early May in southern England. Adults mate a few days after emergence. They feed by eating margins of leaves. No noticeable weight increase is observed in the male, but females become noticeably larger when gravid. Egg laying begins after a pre-oviposition period of 6–11 d. The oviposition period lasts about 44 d, begins in early May, peaking at the end of the month. The eggs are enveloped with a glutinous matter, and laid in batches on the underside of leaves. The number of eggs laid in a batch ranges from 17 to 98. Fecundity measured in the field varied from 835 to 1,016 eggs per female in the first generation, to 587 to 1,028 eggs in the second. The oviposition period lasts 43–45 d in the first generation, 19–33 d in the second. A partial third generation may occur in some years. The number of generations is not fixed and these develop continuously one after the other over the year. First instars feed on the egg chorion before feeding on the host plant. First instars fenestrate the leaves, remaining on those on which they hatch, whereas second and third instars chew holes through the leaves and tend to move from plant to plant. When fully developed, they enter the soil where they pupate in an earthen cell. A complete life cycle was obtained in 19−29 d. Adults of the first generation emerged from the soil in late June and early July in southern England. The total duration of the development of the first generation varied from 35 to 69 d, that of the second generation from 31 to 53 d (LeSage & Majka 2009).

Distribution. The species occurs throughout the Palearctic region from Europe east to Siberia, China, and Korea. It was introduced into North America during the nineteenth century (LeSage & Majka 2009).

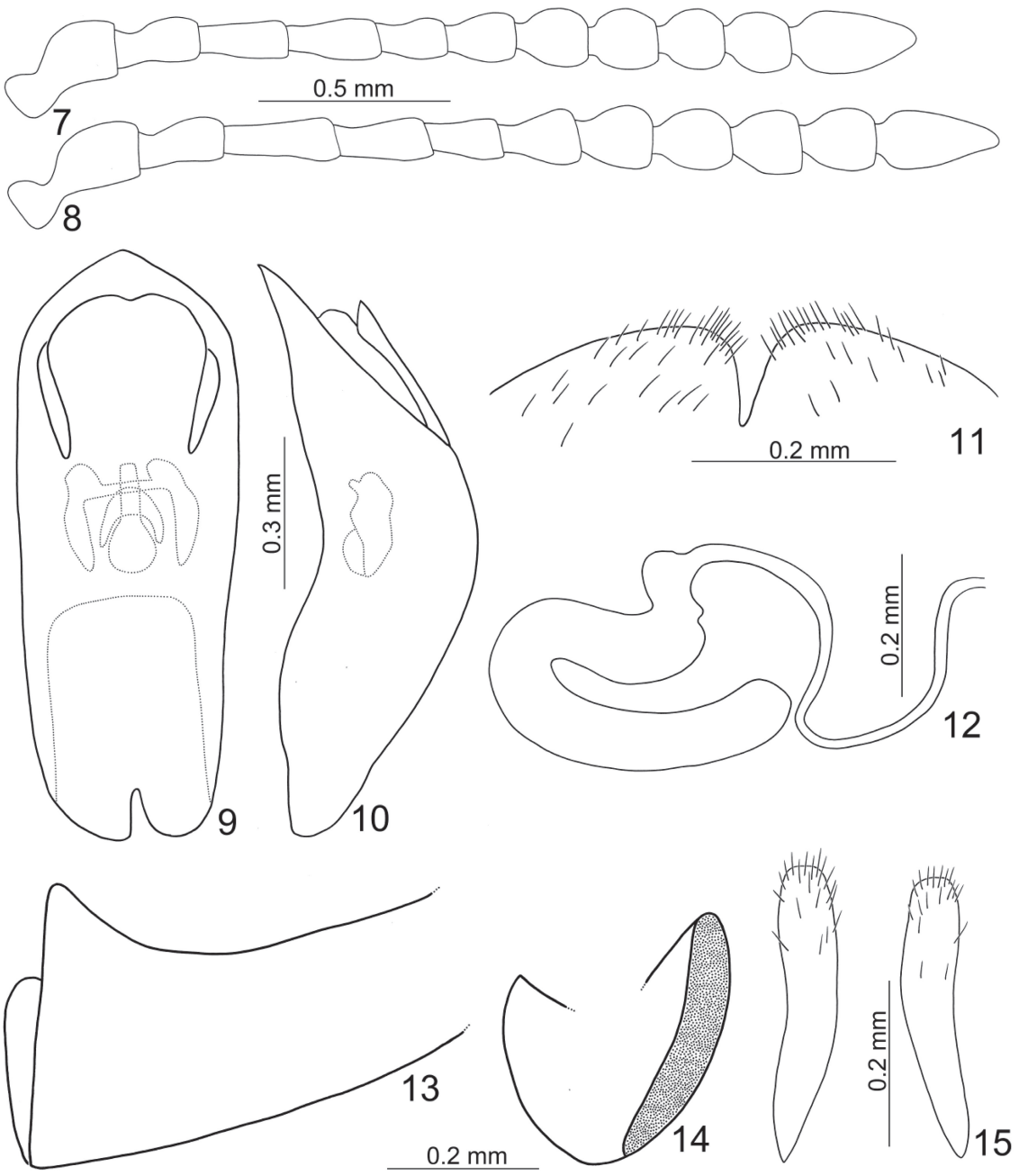
CONCLUSION

Although most species of *Gastrophysa* can be identified based on color patterns, other morphological characters were studied and illustrated before. Jolivet (1951) illustrated the aedeagus of each species of the genus, but they are less diagnostic because only the outlines were provided. Actually, shapes of the endophallic sclerites are diagnostic based on study of *G. atrocyanea* and *G. polygoni*. Such structures were omitted by Jolivet (1951) and other studies (such as Yang *et al.* 2015). In the current study, antennae of both sexes and spermatheca are not used for species identification but are useful for generic diagnosis. In addition to aedeagus, the abdominal ventrite VIII in females and gonocoxae are proved to be diagnostic for species identities.

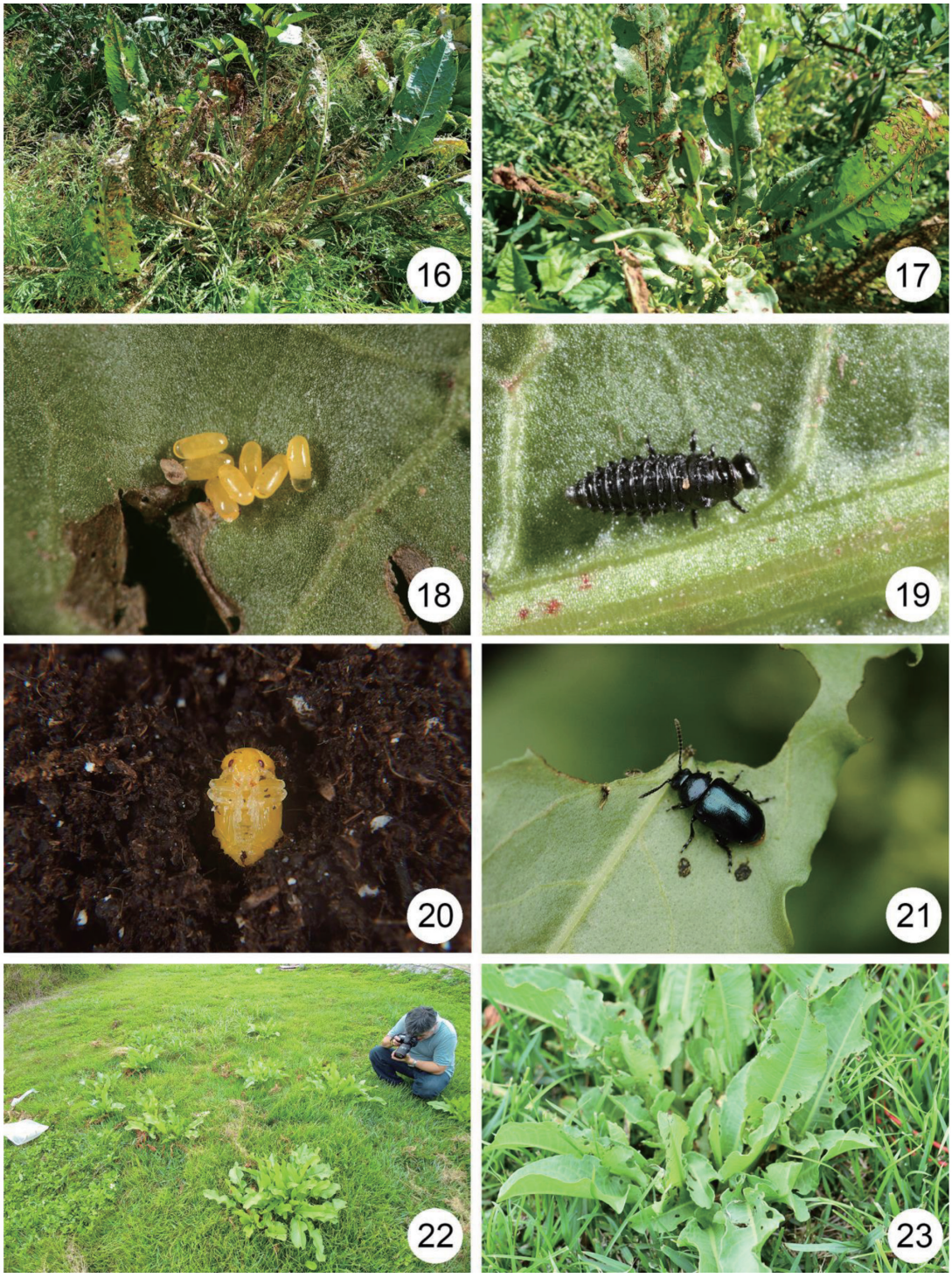
Based on field observations in Kinmen islands during 2022, *Rumex nipponicus* is the true host plant for *Gastrophysa atrocyanea*. Both larvae and adults were observed feeding on the leaves. The overwintered adults probably left from their winter shelters as early as mid-February since some newly emerged adults as well as



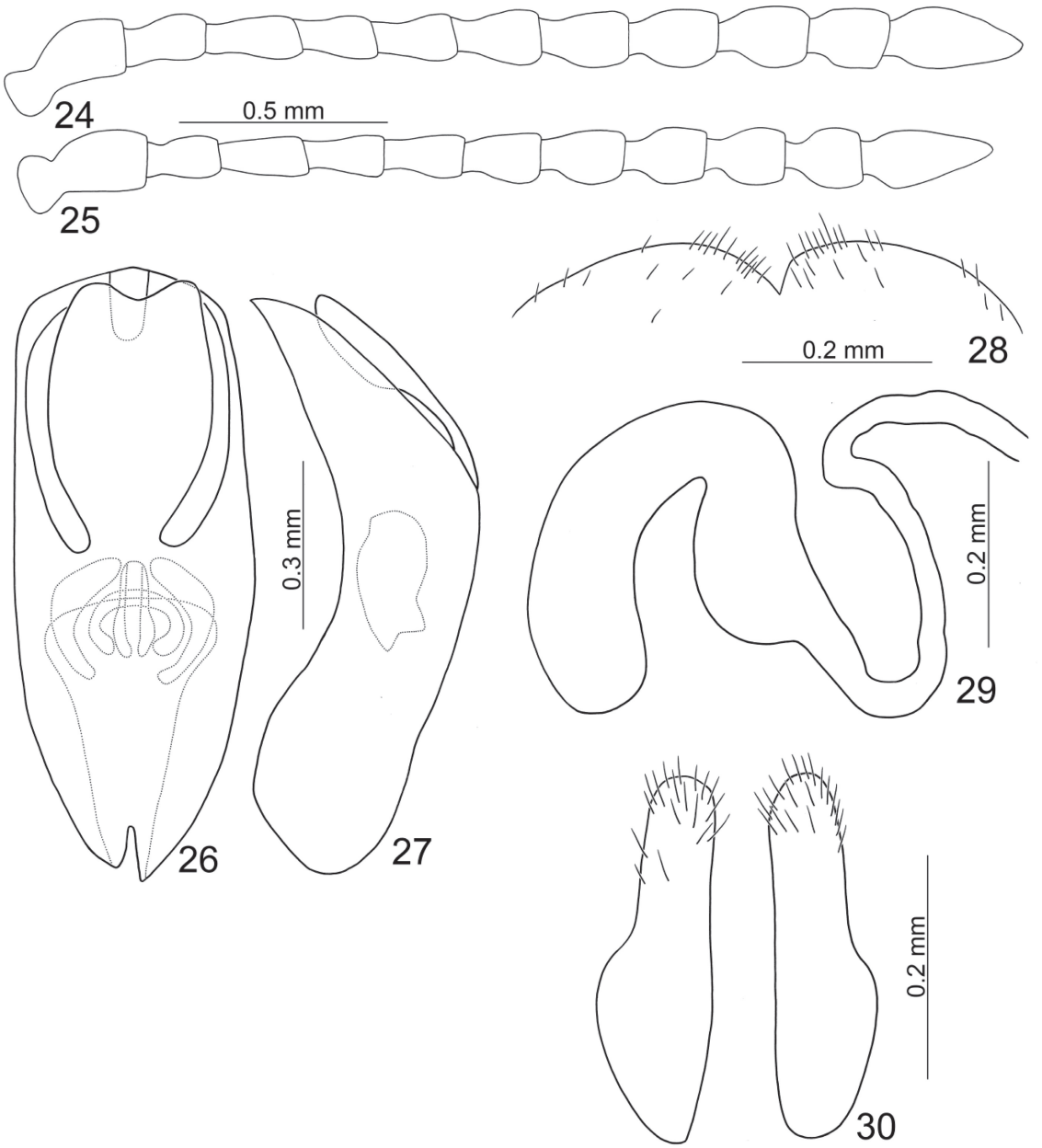
Figs. 1–6. Habitus of adult *Gastrophysa* species. 1. *G. atrocyanea*, dorsal view; 2. Ditto, ventral view; 3. Ditto, lateral view; 4. *G. polygoni*, female, dorsal; 5. Ditto, ventral view; 6. Ditto, lateral view.



Figs. 7–15. Diagnostic characters of *Gastrophysa atrocyanea*. 7. Antenna, male; 8. Antenna, female; 9. Aedeagus, dorsal view; 10. Aedeagus, lateral view; 11. Ventrite VIII, female; 12. Spermatheca; 13. Apical half of tibia of hind leg, lateral view; 14. Apex of tibia of hind leg, front view; 15. Gonocoxae.



Figs. 16–23. Field photographs of *Gastrophysa atrocyanea*. 16. *Rumex nipponicus* seriously defoliated caused by larvae of *G. atrocyanea* in March 9, 2022, at Jincheng (金城) township; 17. At same locality and date, damage caused by larvae on leaves of *R. nipponicus*; 18. Egg batch; 19. Third-instar larva; 20. Pupa; 21. Adult; 22. Population of *R. crispus* on April 13, 2022, at Jinchu (金湖) township; 23. Damage on leaves of *R. crispus*.



Figs. 24–30. Diagnostic characters of *Gastrophysa polygoni*. 24. Antenna, male; 25. Antenna, female; 26. Aedeagus, dorsal view; 27. Aedeagus, lateral view; 28. Ventrite VIII, female; 29. Spermatheca; 30. Gonocoxae.

eggs were found on March 8. These adults didn't mate but were feeding and became inactive in a few days. Based on presence of eggs during early March, and assuming about one month to go through larval and pupal stages (Xiaoshui 1991), the adults would appear during early to mid-April. All of *R. nipponicus* would be dead by that time. Adults would disperse to search for suitable food plants. This could explain why only adults were observed feeding on *R. crispus* on April 13 at a different locality.

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蓼藍齒脛金花蟲 [*Gastrophysa atrocyanea* (Motschulsky, 1860)] 和蓄齒脛金花蟲 [*G. polygoni* (Linnaeus, 1758)] 的重新描述與蓼藍齒脛金花蟲的生物學注解 (鞘翅目：金花蟲科：金花蟲亞科)

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摘要

李奇峰。2022。蓼藍齒脛金花蟲 [*Gastrophysa atrocyanea* (Motschulsky, 1860)] 和蓄齒脛金花蟲 [*G. polygoni* (Linnaeus, 1758)] 的重新描述與蓼藍齒脛金花蟲的生物學注解 (鞘翅目：金花蟲科：金花蟲亞科)。台灣農業研究 71(4):281–292。

蓼藍齒脛金花蟲 (*Gastrophysa atrocyanea*) 是只在春天才出現的金花蟲；除了雄性生殖器，還針對觸角、雌蟲生殖突基節、雌蟲受精囊及雌蟲的第八腹節腹板加以描繪；並藉由跟另外一個廣泛分佈種蓄齒脛金花蟲 (*G. polygoni*) 相互比對，來測試這些特徵是否有診斷價值；並對此種生物學包括幼蟲及成蟲的取食行為、寄主植物及生活史提供更詳細的資料。

關鍵詞：分類學、金花蟲、蓼科、小羊蹄、皺葉酸模。

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