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Single Taxon Treatment

Brachymna tenuis Stål, 1861 (Hemiptera: Pentatomidae), a new invasive bamboo pest in Korea with notes on insects associated with bamboos

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Abstract

Background

We report first observations of the invasive bamboo pest, *Brachymna tenuis* Stål, 1861 in Korea as the first species of *Brachymna* Stål, 1861 (Pentatomidae) reported from the country.

New information

Comments on its pest status and distribution are provided. General information on this bamboo-feeding insect in Korea is analysed and provided for the first time.

Keywords

bamboo, invasive, pest, distribution, *Brachymna*, Korea

Introduction

Bamboo grows in the tropics and subtropics and has received increasing attention because of its fast-growing nature, social usage and industrial demand, for example, foods, crafts, building material and energy resource (Kim et al. 2018). In Korea, there are 18 species of bamboos distributed mostly in the southern part of the country (Kong 1985). Amongst them, eleven dominant bamboo species either occur naturally or are planted and they occupy more than 22 thousand hectares (Kim et al. 2018). The number of insects that feed on bamboos is estimated to be more than 1200 insects in the world (Shu and Wang 2015). The numbers may vary depending on the country and province, ranging from 97 to 244 insect species feeding on bamboos in China (Huang and Liu 2006, Zhao et al. 2006, Zhang and Zuo 2015). In Korea, the review of the entire bamboo-feeding insects has never been done before.

Bamboo pest, *Brachymna tenuis* Stål, 1861 and its synonym, *Balsa extenuata* Walker, 1867 were described from Hong Kong and the Chinese mainland, respectively and subsequent records were made from twelve Provinces in China (Hoffmann 1932, Hsiao and Zheng 1977, Rider et al. 2002, Aukema and Rieger 2006, Huang and Liu 2006, Zhao et al. 2006, Zhang et al. 2008, Zhang and Zuo 2015), Japan (Aukema and Rieger 2006, Ishikawa et al. 2012, Tanaka 2013, Tanaka 2014, Igasaki 2016, Igasaki 2017, Igasaki 2018, Kanetada 2017) and Taiwan (Taiwan Encyclopedia of Life 2018). Recently, the first three authors observed somewhat large, exotic, invasive, bamboo-feeding stink bugs from southern Korea, which had never been recorded. The aim of the present paper is to report new records of invasive bamboo pest *Brachymna tenuis* from Korea, to discuss the distribution of the species and to provide, for the first time, a list of bamboo-feeding insects in Korea, based on a literature review.

Materials and methods

Surveys were conducted in natural and cultivated bamboos, located in the southern Provinces of South Korea (Gyeongsangnam-do and Jeollanam-do) in 2020. Adults and nymphs were observed by visual inspection. The specimens were morphologically identified using the reference books by Lin and Zhang (1993) and Ishikawa et al. (2012). Photographs of habitus were taken using a DSLR camera (Nikon D500, D7100, Nikon 60 mm Micro). The plant names follow The Plant List (2016). The examined specimens were deposited in the College of Agriculture and Life Science, Seoul National University (SNU), Seoul and the private collections of the authors.

Taxon treatment

Brachymna tenuis Stål, 1861

- Encyclopedia of Life http://taieol.tw/data_objects/93100
- GenBank PRJNA550733

Materials

a. scientificName: *Brachymna tenuis*; order: Hemiptera; family: Pentatomidae; taxonRank: species; nomenclaturalCode: ICZN; genus: *Brachymna*; specificEpithet: *tenuis*; higherGeography: East Asia; South Korea; country: South Korea; stateProvince: Gyeongsangnam-do; municipality: Jinju-si; locality: Gajwa-dong, San 113-1; samplingProtocol: visual inspection; eventDate: 2020-06-11; year: 2020; month: 6; day: 11; habitat: *Semiarundinaria* sp.; individualCount: 16; sex: 3 males, 3 females, 10 nymphs; lifeStage: 6 adults, 10 nymphs; preparations: in 95% ethanol; establishmentMeans: invasive; recordedBy: S. Ahn; W.G. Kim; occurrenceStatus: present; disposition: in collection; identifiedBy: S. Ahn; W.G. Kim; S. Kim; G. Cho; dateIdentified: 2020-07; language: en; institutionCode: SNU; basisOfRecord: PreservedSpecimen

b. scientificName: *Brachymna tenuis*; order: Hemiptera; family: Pentatomidae; taxonRank: species; nomenclaturalCode: ICZN; genus: *Brachymna*; specificEpithet: *tenuis*; higherGeography: East Asia; South Korea; country: South Korea; stateProvince: Gyeongsangnam-do; municipality: Haman-gun; locality: Beopsu-myeon, Jumul-ri, San 1; samplingProtocol: visual inspection; eventDate: 2020-06-25; year: 2020; month: 6; day: 25; habitat: *Semiarundinaria* sp.; individualCount: 2; sex: 2 nymphs; lifeStage: 2 nymphs; preparations: in 95% ethanol; establishmentMeans: invasive; recordedBy: S. Ahn; occurrenceStatus: present; disposition: in collection; identifiedBy: S. Ahn; W.G. Kim; S. Kim; G. Cho; dateIdentified: 2020-07; language: en; institutionCode: SNU; basisOfRecord: PreservedSpecimen

c. scientificName: *Brachymna tenuis*; order: Hemiptera; family: Pentatomidae; taxonRank: species; nomenclaturalCode: ICZN; genus: *Brachymna*; specificEpithet: *tenuis*; higherGeography: East Asia; South Korea; country: South Korea; stateProvince: Gyeongsangnam-do; municipality: Changwon-si; locality: Masanhoewon-gu, Guam-dong 669-9; samplingProtocol: visual inspection; eventDate: 2020-06-28; year: 2020; month: 6; day: 28; habitat: *Semiarundinaria* sp.; individualCount: 3; sex: 3 nymphs; lifeStage: 3 nymphs; preparations: in 95% ethanol; establishmentMeans: invasive; recordedBy: S. Ahn; occurrenceStatus: present; disposition: in collection; identifiedBy: S. Ahn; W.G. Kim; S. Kim; G. Cho; dateIdentified: 2020-07; language: en; institutionCode: SNU; basisOfRecord: PreservedSpecimen

d. scientificName: *Brachymna tenuis*; order: Hemiptera; family: Pentatomidae; taxonRank: species; nomenclaturalCode: ICZN; genus: *Brachymna*; specificEpithet: *tenuis*; higherGeography: East Asia; South Korea; country: South Korea; stateProvince: Gyeongsangnam-do; municipality: Jinju-si; locality: Gajwa-dong 952-1; samplingProtocol: visual inspection; eventDate: 2020-07-11; year: 2020; month: 7; day: 11; habitat: *Semiarundinaria* sp.; individualCount: 4; sex: 1 male, 3 nymphs; lifeStage: 1 adult, 3 nymphs; preparations: in 95% ethanol; establishmentMeans: invasive; recordedBy: S. Ahn; occurrenceStatus: present; disposition: in collection; identifiedBy: S. Ahn; W.G. Kim; S. Kim; G. Cho; dateIdentified: 2020-07; language: en; institutionCode: SNU; basisOfRecord: PreservedSpecimen

e. scientificName: *Brachymna tenuis*; order: Hemiptera; family: Pentatomidae; taxonRank: species; nomenclaturalCode: ICZN; genus: *Brachymna*; specificEpithet: *tenuis*; higherGeography: East Asia; South Korea; country: South Korea; stateProvince: Gyeongsangnam-do; municipality: Hadong-gun; locality: Yangbo-myeon, Jangam-ri 419; samplingProtocol: visual inspection; eventDate: 2020-07-15; year: 2020; month: 7; day: 15; habitat: *Miscanthus sinensis* Andersson; individualCount: 1; sex: 1 nymph; lifeStage: 1 nymph; preparations: in 95% ethanol; establishmentMeans: invasive; recordedBy: S. Ahn; occurrenceStatus: present; disposition: in collection; identifiedBy: S. Ahn; W.G. Kim; S. Kim; G. Cho; dateIdentified: 2020-07; language: en; institutionCode: SNU; basisOfRecord: PreservedSpecimen

Diagnosis

According to Lin and Zhang (1993), *Brachymna tenuis* resembles *B. castanea*. It differs from the latter by the yellowish-brown body colour (Fig. 1a, b) (ferruginous in *B. castanea*) and the pygophore bearing dentate postero-lateral processes that are obtusely curved from the postero-ventral margin (Fig. 1c) (postero-lateral processes make approximately a right angle with the postero-ventral margin in *B. castanea*).

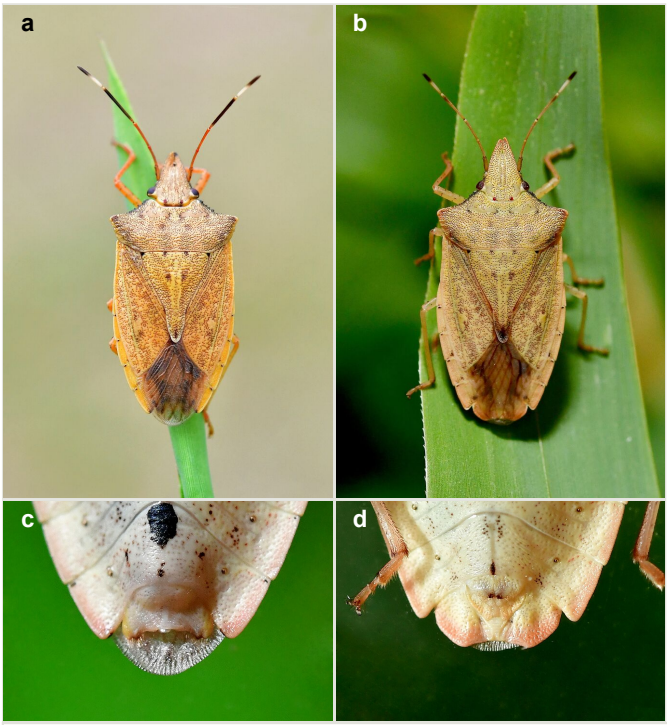

Figure 1.

Brachymna tenuis Stål, 1861.

a: Adult male, dorsal view. doi
b: Adult female, dorsal view. doi
c: Apex of abdomen of male, ventral view. doi
d: Apex of abdomen of female, ventral view. doi

Distribution

China, Japan, Taiwan and South Korea (new record).

Analysis

Provisionally, 61 species are associated with bamboos in South Korea with the majority of the insects belonging to sap-sucking Hemiptera (52.46%). They are mainly polyphagous and include mostly aphids and scale insects. Lepidoptera are the second largest group, making up 31.15% of the total; these include many defoliators, leaf-rollers and one bamboo-shoot cutworm (*Bambusiphila vulgaris*). Coleoptera are the third order, with 14.75% of the species, which include deleterious bamboo borers, such as *Chlorophorus annularis* (Cerambycidae) and *Dinoderus* spp. (Bostrichidae). The bamboo-feeding sawfly *Tenthredo nigropicta* (Tenthredinidae) is included in the list as the only member of Hymenoptera (Table 1).

Table 1.

Provisional list of insect species feeding on bamboos in Korea. The species that possibly damages bamboo is marked with *.

Insect	Host plants with reference	Feeding habits with reference
COLEOPTERA		
Bostrichidae		
Dinoderus japonicus Lesne, 1895	*Phyllostachys*, *Pleioblastus* (Bieńkowski and Orlova-Bienkowskaja 2017)	Borer (Bieńkowski and Orlova-Bienkowskaja 2017)
Dinoderus minutus (Fabricius, 1775)	*Bambusa* spp., *Dendrocalamus* spp., *Phyllostachys* spp. (Watanabe et al. 2018, CABI 2020)	Borer (Mori and Arai 1979, Watanabe et al. 2018, CABI 2020)
Lyctus brunneus (Stephens, 1830)	Bamboo (Liu and Geis 2019)	Borer (Mori and Arai 1979)
Cerambycidae		
Bumetopia oscitans Pascoe, 1858	*Arundinaria simonii* (Park 2015)	Borer (Park 2015)

Insect	Host plants with reference	Feeding habits with reference
Chlorophorus annularis (Fabricius, 1787)	Bamboos; *Bambusa* spp., *Chimonobambusa tumidissinoda*, *Dendrocalamus strictus*, *Indosasa crassiflora*, *Phyllostachys* spp., *Sinobambusa gibbosa*, *Sinocalamus* spp. (Mori and Arai 1979, Hill 2008, Lim et al. 2014, Suma and Bella 2018)	Borer (Mori and Arai 1979, Hill 2008, Suma and Bella 2018)
Purpuricenus temminckii Guerin-Meneville, 1844	*Phyllostachys* spp., *Sasa* spp. (Mori and Arai 1979, Lim et al. 2014)	Borer (Mori and Arai 1979)
Niphona furcata (Bates, 1873)	*Phyllostachys*, *Pleioblatus*, *Pseudosasa japonica*, *Sasa* spp. (Haoje et al. 2002, Lim et al. 2014)	Borer (Haoje et al. 2002)
Nitidulidae		
Epuraea submicrurula Reitter, 1875	*Sasa* spp. (Sakata et al. 2020) (North Korea)	Florivory (Sakata et al. 2020)
Ptinidae		
Oligomerus japonicus Sakai, 1982*	Unknown	Unknown
HEMIPTERA		
Aclerdidae		
Nipponaclerda biwakoensis (Kuwana, 1907)	*Sasa borealis* (García-Morales et al. 2016, Suh 2020)	Sap-sucking
Alydidae		
Distachys unicolor (Scott, 1874)	*Sasa borealis* (Ahn et al. 2018)	Sap-sucking
Distachys vulgaris Hsiao, 1964	*Sasa borealis* (Ahn et al. 2018)	Sap-sucking
Asterolecaniidae		
Bambusaspis bambusicola (Kuwana, 1916)	*Bambusa* spp., *Phyllostachys* spp. (García-Morales et al. 2016, Suh 2020)	Sap-sucking
Aphididae		
Ceratoglyphina styracicola (Takahashi, 1921)	Bamboos (*Arundinaria* or *Pleioblastus*) (Blackman and Eastop 2020)	Sap-sucking
Ceratovacuna cerbera Aoki, Kurosu, Shin & Choe, 1999	*Sasa* spp. including *S. borealis* and *S. veichii* (Aoki et al. 1999, Aoki and Kurosu 2010, Blackman and Eastop 2020)	Sap-sucking

Insect	Host plants with reference	Feeding habits with reference
Ceratovacuna japonica (Takahashi, 1924)	Small bamboos (*Arundinaria*, *Bambusa*, *Sasa* sp.) (Blackman and Eastop 2020)	Sap-sucking
Melanaphis bambusae (Fullaway, 1901)	Bamboos (*Arundinaria*, *Bambusa*, *Phyllostachys*) (Blackman and Eastop 2020)	Sap-sucking
Paracolopha morrisoni (Baker, 1919)	Bamboos (*Arundinaria*, *Phyllostachys*, *Sasa* spp.) (Blackman and Eastop 2020)	Sap-sucking
Rhopalosiphum rufiabdominale (Sasaki, 1899)	Numerous species of Poaceae (Blackman and Eastop 2020)	Sap-sucking
Takecallis alba Lee, 2018	*Pseudosasa* sp., *Sasa* spp. (Lee and Lee 2018, Blackman and Eastop 2020, Rakhshani et al. 2020)	Sap-sucking
Takecallis arundicolens (Clarke, 1903)	*Arundinaria* spp., *Bambusa* spp., *Phyllostachys* spp., *Pleioblastus chino*, *Pseudosasa japonica*, *Sasa* spp., *Sasaella ramosa* (Lee and Lee 2018, Blackman and Eastop 2020, Rakhshani et al. 2020)	Sap-sucking
Takecallis arundinariae (Essig, 1917)	*Arundinaria* spp., *Bambusa* spp., *Dendrocalamus* spp., *Phyllostachys* spp., *Pseudasasa japonica*, *Sasa* spp., *Sinoarundinaria reticulata*, *Sinobambusa tootsik*) (Lee and Lee 2018, Blackman and Eastop 2020, Rakhshani et al. 2020)	Sap-sucking
Takecallis taiwana (Takahashi, 1926)	*Arundinaria* spp., *Bambusa* spp., *Dendrocalamus asper*, *Phyllostachys* spp., *Pleioblastus* spp., *Sasa* spp., *Shibataea kumasana*) (Lee and Lee 2018, Blackman and Eastop 2020, Rakhshani et al. 2020)	Sap-sucking
Blissidae		
Dimorphopterus japonicus (Hidaka, 1959)	*Chimonobambusa marmorea*, *Sasa senanensis* (Sakata et al. 2020)	Florivory, sap-sucking (Sakata et al. 2020)
Cicadellidae		
Scaphoideus festivus Matsumura, 1902	Bamboo (Yang et al. 2013)	Sap-sucking
Coccidae		
Coccus hesperidum Linnaeus, 1759	Various plants of 346 genera in 121 families including *Bambusa vulgaris* (García-Morales et al. 2016, Choi and Lee 2018)	Sap-sucking
Diaspididae		
Kuwanaspis hikosani (Kuwana, 1902)	*Arundinaria simonii*, *Bambusa* spp., *Phyllostachys* spp., *Sasa* sp.) (Suh and Hodges 2007, García-Morales et al. 2016, Malumphy and Salisbury 2016, Suh 2020)	Sap-sucking
Kuwanaspis howardi (Cooley, 1898)	*Arundinaria*, *Bambusa* spp., *Fargesia nitida*, *Phyllostachys* spp. (Suh and Hodges 2007, García-Morales et al. 2016, Malumphy and Salisbury 2016, Suh 2020)	Sap-sucking

Insect	Host plants with reference	Feeding habits with reference
Kuwanaspis pseudoleucaspis (Kuwana, 1902)	*Arundinaria* spp., *Bambusa*, *Drepanostachyum*, *Fargesia*, *Himalayacalamus*, *Phyllostachys* spp., *Pleioblastus*, *Pseudosasa japonica*, *Sasa* spp., *Semiarundinaria*, *Sinobambusa* spp. (Suh and Hodges 2007, García-Morales et al. 2016, Suh 2020)	Sap-sucking
Odonaspis secreta (Cockerell, 1896)	*Arundinaria*, *Phyllostachys* spp., *Pseudosasa*, *Sasa* spp. (Suh and Hodges 2007, Kang et al. 2008, Suh 2020)	Sap-sucking
Unachionaspis tenuis (Maskell, 1897)	*Arundinaria simonii*, *Bambusa*, *Phyllostachys* spp., *Pleioblastus*, *Sasa*, *Shibataea* spp. (Suh and Hodges 2007, García-Morales et al. 2016, Suh 2020)	Sap-sucking
Eriococcidae		
Acanthococcus onukii (Kuwana, 1902)	*Bambusa*, *Phyllostachys nigra*, *Pseudosasa*, *Sasa* (García-Morales et al. 2016, Suh 2020)	Sap-sucking
Miridae		
Erimiris tenuicornis Miyamoto & Hasegawa, 1967	*Sasa* sp. (Kerzhner 1988, Ahn et al. 2018)	Sap-sucking
Pentatomidae		
Aenaria lewisi (Scott, 1874)	Bamboo (Yasunaga et al. 1993)	Sap-sucking
Brachymna tenuis Stål, 1861 (new record)	Bamboos (*Phyllostachys*, *Semiarundinaria*) (Huang and Liu 2006, Zhao et al. 2006, Shu and Wang 2015, Zhang and Zuo 2015)	Sap-sucking (Shu and Wang 2015)
Pseudococcidae		
Antonina crawi Cockerell, 1900	*Arundinaria* spp., *Bambusa*, *Indocalamus herklotsii*, *Phyllostachys* spp., *Pleioblastus*, *Pseudosasa* spp., *Sasa* spp., *Semiarundinaria fastuosa* (García-Morales et al. 2016, Suh 2020)	Sap-sucking
Antonina nakaharai Williams & Miller, 2002	*Arundinaria simonii*, *Phyllostachys* spp. (Lee and Suh 2011, Suh 2020)	Sap-sucking
Brevennia pulveraria (Newstead, 1892)	*Sasa* (García-Morales et al. 2016)	Sap-sucking
Trionymus hamberdi (Borchsenius, 1949)	Various bamboos including *Pseudosasa japonica* (Li et al. 2014, Ülgentürk et al. 2014, García-Morales et al. 2016, Suh 2020)	Sap-sucking
Palmicultor lumpurensis (Takahashi, 1951)	Various bamboos (Li et al. 2014, Ülgentürk et al. 2014, García-Morales et al. 2016)	Sap-sucking

Insect	Host plants with reference	Feeding habits with reference
Pseudococcus comstocki (Kuwana, 1902)	*Sasa borealis* (García-Morales et al. 2016, Suh 2020)	Sap-sucking
HYMENOPTERA		
Tenthredinidae		
Tenthredo nigropicta (Smith, 1874)	*Pleioblastus* spp. (Shinohara and Ibuki 2018)	Defoliator (Shinohara and Ibuki 2018)
LEPIDOPTERA		
Crambidae		
Circobotys aurealis (Leech, 1889)	*Bambusa* spp., *Phyllostachys* spp., *Pleioblastus* spp. (Haoje et al. 2002)	Leaf-roller (Shu and Wang 2015)
Crypsiptya coclesalis (Walker, 1859) (not confirmed)	*Arundinaria, Bambusa* spp., *Dendrocalamus* spp., *Kinabaluchloa wrayi*, *Phyllostachys* spp., *Schizostachyum pergracile*, *Thyrsostachys oliveri* (Sibuea et al. 2020)	Leaf-roller (Sibuea et al. 2020)
Demobotys pervulgalis (Hampson, 1913)	Bamboo (Shu and Wang 2015)	Leaf-roller (Shu and Wang 2015)
Sinibotys butleri (South, 1901)	*Phyllostachys* spp. (Lee et al. 2019)	Possibly leaf-roller (not confirmed)
Sinibotys evenoralis (Walker, 1859)	*Bambusa* spp., *Phyllostachys* spp., *Pleioblastus* spp. (Kim and Lee 1986, Haoje et al. 2002, Robinson et al. 2010)	Leaf-roller (Kim and Lee 1986)
Erebidae		
Amata germana Felder, 1862	Bamboo (Kishida 2011b)	Probably defoliator
Rivula aequialis (Walker, 1863)	Bamboo (Kononenko and Pinratana 2013)	Probably defoliator
Rivula sericealis (Scopoli, 1763)	Bamboo (Kishida 2011b)	Probably defoliator
Lasiocampidae		
Euthrix albomaculata (Bremer, 1861)	Bamboo (Robinson et al. 2010, Kishida 2011a)	Probably defoliator
Noctuidae		
Bambusiphila vulgaris (Butler, 1886)	Bamboos; *Phyllostachys aurea*, *Pleioblastus hindsii* (Yoshimatsu et al. 2005, Kang et al. 2008)	Bamboo-shoot cutworm (Hill 2008, Kang et al. 2008)

Insect	Host plants with reference	Feeding habits with reference
Triphaenopsis jezoensis Sugi, 1962	Dwarf bamboo (Keiko et al. 2012)	Florivory, larvae feeding spikelets and caryopses (Keiko et al. 2012)
Triphaenopsis lucilla Butler, 1878	Bamboo (Sugi 1987, Choi 2008)	Probably defoliator
Notodontidae		
Mimopydna pallida (Butler, 1877)	*Sasa* (Robinson et al. 2010)	Probably defoliator
Zygaenidae		
Artona martini Efetov, 1997	Bamboos (Byun et al. 2010, Marianelli et al. 2020)	Defoliator (Byun et al. 2010)
Balataea gracilis (Walker, 1865)	Bamboo (Hirowatari et al. 2013)	Probably defoliator
Balataea octomaculata (Bremer, 1861)	Bamboo (Hirowatari et al. 2013)	Probably defoliator
Fuscartona funeralis (Butler, 1879)	Bamboos (Kang et al. 2008, Hirowatari et al. 2013)	Defoliator (Kang et al. 2008)
ORTHOPTERA		
Tettigoniidae		
Conocephalus bambusanus Ingrisch, 1990	*Pseudosasa* spp. (Kim and Kim 2002)	Probably defoliator
Palaeoagraecia lutea (Matsumura & Shiraki, 1908)	*Pseudosasa* (Kim and Lee 2019)	Probably defoliator

The invasive stink bug was identified as *Brachymna tenuis* Stål, 1861 (Hemiptera: Heteroptera: Pentatomidae) that is recorded in South Korea for the first time (Figs 1, 2). It is one of the most important pest species feeding on bamboo branch and culm. A heavy infestation may cause defoliation, wilting of young shoots and branches and even death of the culm (Shu and Wang 2015). The species is polyphagous and is reported from various bamboo species in South Korea, for example, *Phyllostachys elegans* McClure and *Semiarundinaria densiflora* (Rendle) T.H.Wen (Poaceae). Sometimes, it feeds also on *Miscanthus sinensis* Andersson (Poaceae). Numerous adults and nymphs were observed on planted bamboos in the urban areas of Korean southern provinces. The species was

also observed in Busan-si, Gwangyang-si and Yeosu-si without detailed collection data (Fig. 3).

Figure 2.

Brachymna tenuis Stål, 1861.

a: Third instar nymph. doi
b: Fourth instar nymph. doi
c: Fifth instar nymph. doi

Discussion

In East Asia, *Brachymna tenuis* is widespread in many tropical and subtropical Chinese Provinces (Anhui, Fujian, Guangdong, Guizhou, Henan, Hong Kong, Hubei, Hunan, Jiangsu, Jiangxi, Sichuan, Yunnan and Zhejiang) (Hoffmann 1932, Hsiao and Zheng 1977, Rider et al. 2002, Aukema and Rieger 2006, Huang and Liu 2006, Zhao et al. 2006, Zhang et al. 2008, Zhang and Zuo 2015) and it has been reported from subtropical Japanese Prefectures (Ryukyu, Oita and Yamaguchi) (Aukema and Rieger 2006, Tanaka 2013, Tanaka 2014, Igasaki 2016, Igasaki 2017, Igasaki 2018, Kanetada 2017) and Taiwan (Taiwan Encyclopedia of Life 2018). In Japan, after the first observation of the species in 1997 (Ishikawa et al. 2012), recent range expansion to the north and abnormal outbreaks have been observed (Tanaka 2013, Tanaka 2014, Igasaki 2017, Igasaki 2018). In South Korea, it was first found in 2020 on planted bamboos in the southern provinces (present paper). Since 2010, the first three authors carried out extensive field monitoring research

mainly on terrestrial Hemiptera, but they had not seen any *Brachymna* species before. As the adults of the species have been found along with numerous nymphs in restricted areas, we concluded that the species was very recently introduced and established into the country. Little is known about the viability and host plant usage of the species in South Korea. More attention is required in order to limit the further spread of the pest species.

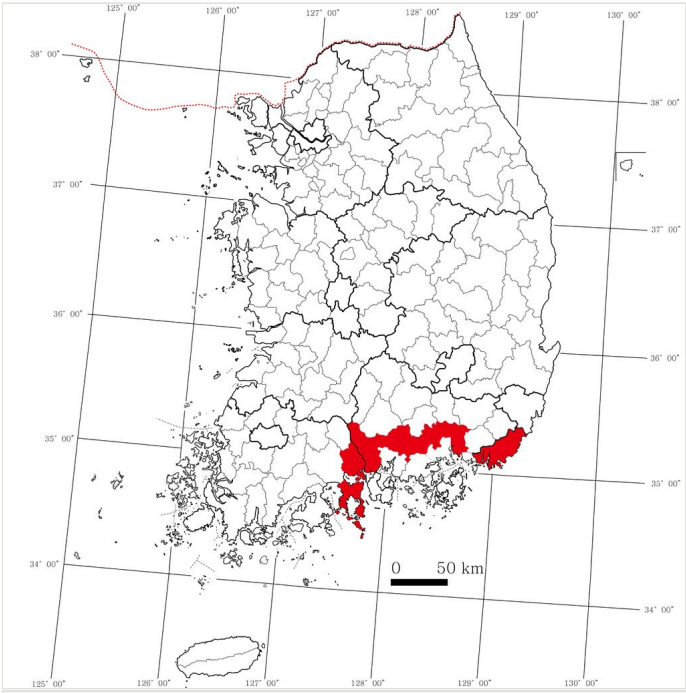

Figure 3. doi

Map showing the distribution of *Brachymna tenuis* in South Korea.

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Author contributions

Geonho Cho wrote the text; Soojeung Ahn, WonGun Kim and Sangsu Kim collected material and provided photographs; all authors revised the manuscript.

References

- Ahn SJ, Kim WG, Kim SS, Park CG (2018) The terrestrial Heteroptera of Korea. Nature & Ecology, Seoul.
- Aoki S, Kurosu U, Shin KY, Choe JC (1999) A new solidier-producing species of *Ceratovacuna* (Homoptera: Aphididae, Hormaphidinae) on *Sasa* spp. from Japan and Korea. Entomological Science 2 (4): 511-516.
- Aoki S, Kurosu U (2010) A review of the biology of Cerataphidini (Hemiptera, Aphididae, Hormaphidinae), focusing mainly on their life cycles, gall formation, and soldiers. Psyche 2010: 380351.
- Aukema B, Rieger C (2006) Catalogue of the Heteroptera of the Palaearctic Region. Volume 5. Pentatomorpha II. Ponsen & Looijen, Wageningen.
- Bieńkowski AO, Orlova-Bienkowskaja MJ (2017) Establishment of the invasive pest of bamboo *Dinoderus japonicus* Lesne, 1895 (Coleoptera Bostrichidae) in the Caucasus and notes on other beetle species currently established in this region. Redia 100: 115-118.
- Blackman RL, Eastop VF (2020) Aphids on the World's plants: an online identification and information guide. http://www.aphidsonworldsplants.info/. Accessed on: 2020-7-21.
- Byun BK, Lee BW, Kim IK, Kim J, Park IK, Shin SC (2010) A first discovery of *Artona martini* Efetov (Lepidoptera: Zygaenidae) from Korea. Journal of Asia-Pacific Entomology 13: 391-393. https://doi.org/10.1016/j.aspen.2010.06.003
- CABI (2020) Invasive Species Compendium. Wallingford, UK: CAB International. http://www.cabi.org/isc. Accessed on: 2020-7-28.
- Choi J, Lee S (2018) Review of the genus *Coccus* Linnaeus from Korea, with description of a new species (Hemiptera, Coccomorpha, Coccidae). ZooKeys 734: 121-135. https://doi.org/10.3897/zookeys.734.22774
- Choi SW (2008) Diversity and composition of larger moths in three different forest types of Southern Korea. Ecological Research 23: 503-509. https://doi.org/10.1007/s11284-007-0406-8
- García-Morales M, Denno BD, Miller DR, Miller GL, Ben-Dov Y, Hardy NB (2016) ScaleNet: A literature-based model of scale insect biology and systematics. Database. doi: 10.1093/database/bav118. http://scalenet.info. Accessed on: 2020-7-21.
- Haoje W, Varma RV, Tiansen X (2002) Insect pests of bamboos in Asia: An Illustrated Manual. Art Options, New Delhi.
- Hill DS (2008) Pests of crops on warmer climates and their control. Springer, Berlin. https://doi.org/10.1007/978-1-4020-6738-9
- Hirowatari T, Nasu Y, Sakamaki Y, Kishida Y (2013) The standard of moths in Japan. III. Gakken Education Publishing, Tokyo. [In Japanese].
- Hoffmann WE (1932) A List of the Pentatomidae, Plataspidae, and Coreidae (order Hemiptera) of China, Korea, and Indo-China. Journal of the Pan-Pacific Research Institution 7 (1): 6-11.
- Hsiao TY, Zheng LY (1977) Family Pentatomidae . In: Hsiao TY, Ren SZ, Zheng LY, Jing HL, Liu SL (Eds) A Handbook for the Determination of the Chinese Hemiptera-Heteroptera. Volume I. Science Press, Beijing, 53-158, 297-300 pp. [In Chinese].

- Huang CQ, Liu QY (2006) Investigation and research on bamboo forest pests and harmful acarids in Fujian Province. Journal of Fujian Forestry Science and Technology 33 (3): 114-126.
- Igasaki N (2016) Four stink bugs with insufficient information in Yamaguchi Prefecture. Yamaguchi no Mushi 15: 174. [In Japanese].
- Igasaki N (2017) Did the *Brachymna tenuis* in Yamaguchi Prefecture expand its distribution? Yamaguchi no Mushi 16: 147. [In Japanese].
- Igasaki N (2018) Collecting *Brachymna tenuis* at Tokusagamine and expanding the distribution in Yamaguchi Prefecture. Yamaguchi no Mushi 17: 175. [In Japanese].
- Ishikawa T, Takai M, Yasunaga T (2012) Terrestrial Heteropterans: A Field Guide to Japanese Bugs, Volume 3. Zenkoku Noson Kyoiku Kyokai, Publishing Co., Ltd., Tokyo. [In Japanese].
- Kanetada L (2017) Collection of southern species *Brachymna tenuis* . Ōita konchū dōkō-kai kaishi-Nihō no mushi 55: 106. [In Japanese].
- Kang J, Lee S, Park H, Lee Y, Jung H, Kim C (2008) An Illustrated Book of Wood Pest. Sodam Publishing Company, Seoul. [In Korean].
- Keiko K, Kenechi O, Katsuhiko S (2012) First report of *Triphaenopsis jezoensis* (Insecta, Lepidoptera, Noctuidae) feeding on dwarf bamboo spikelets and caryopses. Bamboo Journal 28: 43-46.
- Kerzhner IM (1988) Family Miridae . In: Lehr PA (Ed.) Keys to the Insects of the Far East of the USSR. Vol. 2. Nauka, Leningrad, 778-857 pp. [In Russian].
- Kim C, Baek G, Yoo BO, Jung SY, Lee KS (2018) Regular fertilization effects on the nutrient distribution of bamboo components in a moso bamboo (*Phyllostachys pubescens* (Mazel) Ohwi) stand in South Korea. Forest 9: 671. https://doi.org/10.3390/f9110671
- Kim KJ, Lee TS (1986) Studies on the host plant, bionomics, and damage of bamboo leaf rollers in Chonnam Province area. Korean Journal of Plant Protection 25 (2): 85-92.
- Kim T, Lee KW (2019) A new record of *Palaeoagraecia lutea* (Orthoptera: Tettigoniidae: Conocephalinae: Agraeciini) in Korea. Animal Systematics, Evolution and Diversity 35 (3): 143-150.
- Kim TW, Kim JI (2002) Taxonomic study of the genus *Conocephalus* Thunberg in Korea (Orthoptera: Tettigoniidae: Conocephalinae). Korean Journal of Entomology 32 (1): 13-1. https://doi.org/10.1111/j.1748-5967.2002.tb00003.x
- Kishida Y (2011a) The Standard of Moths in Japan. I. Gakken Education Publishing, Tokyo. [In Japanese].
- Kishida Y (2011b) The Standard of Moths in Japan. II. Gakken Education Publishing, Tokyo. [In Japanese].
- Kong WS (1985) A phytogeographical study on the distribution of bamboos in the Korean Peninsula. Korean Journal of Ecology 8 (2): 89-98. [In Korean].
- Kononenko VS, Pinratana A (2013) Moth of Thailand Vol. 3, Part 2. Noctuoidea. An Illustrated Catalogue of Erebidae, Nolidae, Euteliidae and Noctuidae (Insecta, Lepidoptera) in Thailand. Brothers of St. Gabriel, Bangkok.
- Lee TG, Ko JH, Lee DJ, Kim HK, Cha YB, Bayarsaikhan U, Na SM, Shin YM, Park BS, Bae YS (2019) Two species of Pyraustine moths new to Korea (Lepidoptera: Crambidae). Journal of Asia-Pacific Biodiversity 12: 79-82. https://doi.org/10.1016/j.japb.2018.09.010

- Lee Y, Lee S (2018) A review of the genus *Takecallis* Matsumura in Korea with the description of a new species (Hemiptera, Aphididae). ZooKeys 748: 131-149. https://doi.org/10.3897/zookeys.748.23140
- Lee YH, Suh SJ (2011) Notes on *Antonina* mealybug of Korea (Hemiptera: Pseudococcidae). Korean Journal of Applied Entomology 50 (1): 71-73. https://doi.org/10.5656/KSAE.2011.03.1.077
- Lim J, Jung SY, Lim JS, Jang J, Kim KM, Lee YM, Lee BW (2014) A review of host plants of Cerambycidae (Coleoptera: Chrysomeloidea) with new host records for fourteen cerambycids, including the Asian longhorn beetle (*Anoplophora glabripennis* Motschulsky), in Korea. Korean Journal of Applied Entomology 53 (2): 111-133. https://doi.org/10.5656/KSAE.2013.11.1.061
- Lin YJ, Zhang SM (1993) Hemiptera: Pentatomoidea . In: Huang CM (Ed.) Animals of Longqi Mountain. China Forestry Publishing House, Beijing, 107-123 pp. [In Chinese].
- Liu LY, Geis KU (2019) A synopsis of the Lyctine beetles of Eurasia with a key to the species (Insecta: Coleoptera: Bostrichidae: Lyctinae). Journal of Insect Biodiversity 9 (2): 34-56. https://doi.org/10.12976/jib/2019.09.2.1
- Li WC, Tsai MY, Wu SA (2014) A review of the legged mealybugs on bamboo (Hemiptera: Coccoidea: Pseudococcidae) occurring in China. Zootaxa 3900 (3): 370-398. https://doi.org/10.11646/zootaxa.3900.3.3
- Malumphy C, Salisbury A (2016) First incursion in Europe of bamboo white scale *Kuwanaspis howardi* (Hemiptera: Diaspididae), with a review of *Kuwanaspis* species detected in Britain. British Journal of Entomology and Natural History 29: 97-105.
- Marianelli L, Iovinella I, Strangi A, Madonni L, Efetov KA, Tarmann GM, Raiola V, Baruzzo F, Sabbatini GP, Roversi PF (2020) First record of the pest Artona (Fuscartona) martini Efetov, 1997 (Lepidoptera Zygaenidae Procridinae Artonini) in European territory. Redia 103: 3-7. https://doi.org/10.19263/REDIA-103.20.01
- Mori H, Arai H (1979) Insect damage in bamboo materials and its prevention. House and Household Insect Pests 1-2: 9-23. [In Japanese].
- Park S (2015) Rediscovery of *Bumetopia oscitans* Pascoe, 1858. Insect Korea, a quarterly Journal of Entomology 2: 45. [In Korean].
- Rakhshani E, Saval JM, Hidalgo NP, Pons X, Kavallieratos G, Stary P (2020) *Trioxys liui* Chou & Chou, 1993 (Hymenoptera, Braconidae, Aphidiinae): an invasive aphid parasitoid attacking invasive *Takecallis* species (Hemiptera, Aphididae) in the Iberian Peninsula. ZooKeys 944: 99-114. https://doi.org/10.3897/zookeys.944.51395
- Rider DA, Zheng LY, Kerzhner IM (2002) Checklist and nomenclatural notes on the Chinese Pentatomidae (Heteroptera). II. Pentatominae. Zoosystematica Rossica 11 (1): 135-153.
- Robinson GS, Ackery PR, Kitching IJ, Beccaloni GW, Hernández LM (2010) HOSTS – A Database of the World's Lepidopteran Hostplants. Natural History Museum, London. http://www.nhm.ac.kr/hosts. Accessed on: 2020-7-22.
- Sakata Y, Kobayashi K, Makita A (2020) Insect assemblages on flowering patches of 12 bamboo species. Journal of Asia-Pacific Entomology 23: 675-679. https://doi.org/10.1016/j.aspen.2020.04.011
- Shinohara A, Ibuki S (2018) Host plant and life history of bamboo-feeding sawfly, *Tenthredo nigropicta* (Hymenoptera, Tenthredinidae) in Japan. Bulletin of the National Museum of Nature and Science Series A 44 (2): 51-55.

- Shu J, Wang H (2015) Pests and diseases of bamboos. In: Liese W, Köhl M (Eds) Bamboo: The Plants and its Uses. Springer International Publishing, Cham, 175-192 pp. https://doi.org/10.1007/978-3-319-14133-6_6
- Sibuea P, Hengki MP, Tarigan M, Tavares WD, Sinulingga NGB, Kkadan SK, Duran A (2020) Infestation of four bamboo species by *Crypsiptya coclesalis* (Lepidoptera, Crambidae) in Sumatra, Indonesia. Journal of the Lepidopterists' Society 74 (2): 121-124. https://doi.org/10.18473/lepi.74i2.a6
- Sugi S (1987) Larvae of larger moths in Japan. Kodansha, Tokyo. [In Japanese].
- Suh SJ, Hodges GS (2007) Identification of armored scales (Hemiptera: Diaspididae) on bamboos in Korea. Journal of Asia-Pacific Entomology 10 (1): 1-3. https://doi.org/10.1016/S1226-8615(08)60322-2
- Suh SJ (2020) Host plant list of the scale insects (Hemiptera: Coccomorpha) in South Korea. Insecta Mundi 0757: 1-26.
- Suma P, Bella S (2018) First interception of the Asiatic bamboo longhorn, *Chlorophorus annularis* (F., 1787) (Coleoptera, Cerambycidae) in Italy. Phytoparasitica 46: 63-68. https://doi.org/10.1007/s12600-017-0632-8
- Taiwan Encyclopedia of Life (2018) *Brachymna tenuis*. http://taieol.tw/data_objects/93100. Accessed on: 2020-7-14.
- Tanaka K (2013) Collecting *Brachymna tenuis* in Yamaguchi Prefecture. Gekkan Mushi 514: 3-4. [In Japanese].
- Tanaka K (2014) Abnormal outbreak of *Brachymna tenuis* in Yamaguchi Prefecture. Gekkan Mushi 526: 21. [In Japanese].
- The Plant List (2016) Version 1.1. Published on the Internet http://www.theplantlist.org/. Accessed on: 2020-7-14.
- Ülgentürk S, Porcelli F, Pellizzari G (2014) The scale insects (Hemiptera: Coccoidea) on bamboos in the Western-Palearctic region: new records and distributional data. Acta Zoologica Bulgarica, Suppl. 6: 77-82.
- Watanabe H, Yanase Y, Fujii Y (2018) Continuous non-destructive monitoring of larval feeding activity and development of the bamboo powderpost beetle *Dinoderus minutus* using acoustic emission. Journal of Wood Science 64: 138-148. https://doi.org/10.1007/s10086-017-1678-4
- Yang L, Chen XS, Li ZZ (2013) Review of the bamboo-feeding species of genus *Scaphoideus* (Hemiptera: Cicadellidae: Deltocephalinae) from China, with description of one new species. Zootaxa 3619 (5): 557-568. https://doi.org/10.11646/zootaxa.3619.5.5
- Yasunaga T, Takai M, Yamashita I, Kawamura M, Kawasana T (1993) A field guide to Japanese bugs. Terrerstrial heteropterans. Zenkoku Noson Kyoiku Kyotai, Publishing Co., Ltd., Tokyo. [In Japanese].
- Yoshimatsu S, Kusigemati K, Gyoutoku N, Kamiwada H, Sato Y, Sakamaki Y (2005) Some lepidopterous pests of bamboo and bamboograss shoots in Japan. Japanese Journal of Entomology (New Series) 8 (3): 91-97. [In Japanese].
- Zhang S, Han DM, Fang J, Wan X, Fan J (2008) The fauna and diversity of Heteroptera insects in Yaoluoping nature reserve. Chinese Bulletin of Entomology 45 (5): 799-805.
- Zhang ZG, Zuo CX (2015) Preliminary study on bamboo-feeding insects in Jinggangshan National Nature Reserve. Journal of Jinggangshan University (Natural Science) 36 (6): 92-98.

- Zhao RY, Jiang TL, Xu ZW, Chen DL, Wu ZM, Yang SL (2006) Identification and risk estimation of bamboo insect species in mountainous area of Lishui. Journal of Zhejiang Forest Science & Technology 26 (4): 58-63.