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Cover photograph: *Promalactis jezonica*, photo by Zhaohui Du & Shuxia Wang

***Errata**: The name of the subject editor for Coleoptera was spelled incorrectly in our previous issues, it should read Paul Aston instead of Ashton.*

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New records of Chinese Necrosciinae (Phasmatodea: Diapheromeridae).

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ABSTRACT

One genus, *Tagesoidea* Redtenbacher, 1908, and three species, *Necroscia robustior* (Redtenbacher, 1908), *Sosibia platycerca* Redtenbacher, 1908 and *Tagesoidea tages* Westwood, 1859, of the subfamily Necrosciinae (Phasmatodea: Diapheromeridae) are reported for the first time from China. The male *N. robustior* and female *S. platycerca* are described and illustrated for the first time.

Key Words: Necrosciinae, *Necroscia robustior*, *Sosibia platycerca*, *Tagesoidea tages*, China.

中國長角枝虫脩亞科新紀錄 (虫脩目: 笛虫脩科)

何維俊

摘要: 本文記述中國長角枝虫脩亞科1新紀錄屬，翡虫脩屬 *Tagesoidea* Redtenbacher，1908和3新紀錄種，健角臀虫脩 *Necroscia robustior* (Redtenbacher，1908)，扁尾健虫脩*Sosibia platycerca* Redtenbacher，1908及斑翅翡虫脩*Tagesoidea tages* Westwood，1859；並首次描述雄性健角臀虫脩和雌性扁尾健虫脩。

INTRODUCTION

The phasmid subfamily Necrosciinae contains only one tribe, the Necrosciini although it has been suggested that some genera may be divided into two tribes in relation to the morphology of the appendicular ovipositor (Bragg, 2001). The subfamily consists of 620 valid species, and is mainly distributed over tropical and subtropical regions (Phasmid Species File Online by Brock, 2013), most of them are winged and able to fly and. No revision work has been carried-out for this subfamily and it is poorly studied. In China, there are more than 100 species of Necrosciinae (Hennemann *et al.*, 2008; Chen and He, 2008; Chen and Zhang, 2008; Ho, 2012a, 2012b, 2013a, 2013b). They are abundant in the southern and southwestern regions including Guangdong, Guangxi, Hainan and Yunnan.

MATERIALS

The types of *Tagesoidea tages* Westwood, 1859, *Necroscia robustior* (Redtenbacher, 1908), and *Sosibia platycerca* Redtenbacher, 1908 were assessed by the descriptions in the relevant literature (Westwood, 1859; Redtenbacher, 1908; Brock, 1998, 1999; Hennemann and Conle, 2013) and images downloaded from Phasmid Species File Online (Brock, 2013). The material discussed below is deposited in the Institute of Zoology, Chinese Academy of Sciences, Beijing, China (IZCAS), Naturhistorisches Museum Wien, Vienna, Austria (NHMW), Hope Entomological Collections, University Museum, Oxford, United Kingdom (UMO) and the private collection of George Ho Wai-Chun, Hong Kong (GH).

The descriptions and illustrations of male *N. robustior* and female *S. platycerca* are based on material collected from Damingshan, south-central Guangxi, China. The collecting trip was conducted in July 2012. The specimens were collected directly by hand at night due to their nocturnal behaviour using a hand torch to spot them on plants.

All specimens examined had the apices of femora and tibiae without area apicalis.

Measurements of the specimens are given in millimeters.

RESULTS

Genus *Necroscia* Audinet-Serville, 1838

Type-species: *Necroscia roseipennis*, Audinet-Serville, 1838: 250 [=*Necroscia prasina* (Burmeister, 1838)], by subsequent designation of Kirby, 1904: 436.

= *Aruanoidea* Brunner von Wattenwyl, 1893: 84 [Synonymised by Hennemann, 1998: 121]

Notes: Ten species are currently recognised in China (Hennemann *et al.*, 2008; Chen and He, 2008; Chen and Zhang, 2008; Ho, 2010, 2013b).

Necroscia robustior (Redtenbacher, 1908)

Aruanoidea robustior, Redtenbacher, 1908: 526.
Brock, 1998: 54.
Otte & Brock, 2005: 214.

Type: Holotype: ♀, Than-Moi, Tonkin, Vietnam, VI–VII, Fruhstorfer, H., catalog no. 1038 (NHMW).

Other material examined: 11♂♂, 7♀♀, Damingshan, Wuming Country, Guangxi Autonomous Region, China, 28–31.VII.2012, George Ho Wai-Chun, GH00402–419 (GH).

Diagnosis: This species is related to *Necroscia westwoodi* Kirby, 1904 [Malay Peninsula, Malaysia and Singapore], but can be separated by its tegmina which has smaller yellowish spot in both sexes; hind margin with deep V-shaped emargination in male; and long and cylindrical cerci in female.

Description of male (Figs. 1–3): Medium-sized, 64–70 mm. Two colour forms including green form and brown form. General color of body and wings uniformly green or brown. Body slim and slender. Similar to female, but distinctly thinner.

Head: Green colour form with a pale yellow postocular stripe; brown colour form with two pale yellow postocular stripes. Smooth, lacking granulation. Oblong, slightly longer than pronotum. Vertex flat, with two flattened depressions between eyes, segregated by median furrow, the depressions distinctly carinate marginally. Occiput flat, with six small swellings at hind margin. Eyes brown with darker markings, rounded and prominent, about 1.4 x the length of the genae. Antennae bluish green dorsally and dark brown ventrally, with pale rings; very long and filiform, longer than the total length of body; the first segment cylindrical, longer than second segment; second segment as long as third segment.

Thorax: Pronotum brown, with inconspicuous and small granules; rectangular, becoming parallel-sided at a quarter of its length, transverse and longitudinal sulci crossing before middle. Mesonotum blackish brown, sparsely covered with small and brownish granules; elongate, 3 x the length of the pronotum, as long as the combined length of metanotum and median segment, broadly emarginated medially. Mesosternum blackish brown, granulated as in mesonotum. Mesopleurum, metapleurum and metasternum green or brown, smooth. Metanotum longer than median segment.

Abdomen: Green form with brown markings, brown form with light brown markings. Cylindrical and smooth. Becoming parallel-sided from the second to seventh terga. Second to fifth terga roughly equal in length. Eighth tergum gently expanded posteriorly. Ninth tergum moderately constricted at two-thirds. Anal segment the shortest among all terga, with deep V-shaped emargination at hind margin, apices thickened and curved inward, inner surfaces with small teeth. Poculum smooth, cup-shaped, tapering posteriorly, apex pointed. Cerci flattened, apices rounded.

Wings: Tegmina with yellow longitudinal stripe marginally in green form, with pale yellow longitudinal stripe marginally in brown form; with a small yellow spot near the elevated shoulder. Alae green with yellow longitudinal stripe marginally in green form, or brown with buff brown markings in brown form; long, reaching posterior of sixth tergum.

Legs: Yellowish brown, with blackish bands. Very slender and slim. Profemora curved basally, distinctly longer than mesonotum.

Measurements are given in Table 1.

Notes: The male is here described and illustrated for the first time.

Distribution: Guangxi (Damingshan), China. Also Vietnam [Type locality].

Genus *Sosibia* Stål, 1875

Type species: *Sosibia nigrispina*, Stål, 1875: 87, by subsequent designation of Rehn, 1904: 71.

Notes: Seven species are recognised in China (Chen and He 2008; Hennemann *et al.*, 2008).

Sosibia platycerca Redtenbacher, 1908

Sosibia platycerca, Redtenbacher, 1908: 536.
Brock, 1998: 50.
Otte & Brock, 2005: 324

Types: Syntype: ♂, Than-Moi, Tonkin, Vietnam, VI–VII, Fruhstorfer, H., catalog no. 1064 (NHMW); Syntype: 2♂♂, 2000–3000 ft., Montes Mauson, Tonkin, IV–V, Fruhstorfer, H., catalog no. 1064 (NHMW).

Other material examined: 6♂♂, 4♀♀, Damingshan, Wuming Country, Guangxi Autonomous Region, China, 30–31.VII.2012, George Ho Wai-Chun, GH00420–429 (GH).

Diagnosis: Related to *Sosibia truncata* Chen & Chen, 2000 [Hong Kong and Guangdong, China], but can be separated by its rounded hind margin of the anal segment in female; and elongate and curved inward cerci in male.

Description of female (Figs. 4–6): Medium-sized, 59–66 mm. General colour of body, legs and wings brown. Head and thorax granulated. Whole body covered with long setae, denser in legs. Similar to male, but distinctly bigger and robust.

Head: Sparsely covered with small and rounded granules. Oblong, about 1.3 longer than wide. Vertex flat, with a small and rounded elevation between the bases of antennae. Occiput slightly convex, median and lateral furrows distinct, with a broad U-shaped carina placed at the anterior region of the occiput. Genae with a short postocular carina behind eyes. Eyes light brown, rounded and small, length about 2.5 x that of the genae. Antennae brown, with darker apices, filiform, longer than forelegs; the first segment distinctly constricted basally, 1.5 x longer than the second segment; third segment cylindrical, as long as second segment.

Thorax: Distinctly covered with small and rounded granules. Pronotum rectangular, as long as head, anterior margin curved, posterior margin truncate, transverse and longitudinal sulci crossing before middle. Mesonotum about 3.5 x the length of the pronotum, slightly parallel-sided, median line distinct. Metanotum slightly shorter than median segment.

Abdomen: Brown as body. Cylindrical, tapering posteriorly. Sixth tergum to anal segment carinate medially and laterally. The second to sixth sterna with small elevation postero-medially. Second tergum the longest among all terga. Third tergum shorter than the second tergum. Fourth to sixth terga equal in length, shorter than the preceding terga. Seventh sterna lacking preopercular organ. Anal segment as long as ninth tergum, slightly shorter than eighth tergum, gently constricted posteriorly, hind margin rounded. Subgenital plate scoop-shaped, with a short lateral carina, apex pointed, reaching middle of the anal segment. Cerci with long setae, flattened, apices rounded, surpassing hind margin of the anal segment.

Wings: Tegmina brown, oval, apparently shorter than head, tapering posteriorly, elevated with a distinct and small black angle medially. Alae brown, short, reaching fifth tergum, anal region gray.

Legs: Brown, with small and light brown markings. Unarmed. Densely covered with long setae. Profemora distinctly curved basally, shorter than mesonotum.

Measurements in Table 1.

Notes: The female is described here for the first time.

Distribution: Guangxi (Damingshan), China. Also Vietnam [Type locality].

Genus *Tagesoidea* Redtenbacher, 1908

Type-species: *Tagesoidea tages*, Westwood, 1859: 152, by subsequent designation of Brock, 1995: 93.

Notes: The genus *Tagesoidea* Redtenbacher, 1908, with *T. tages* Westwood, 1859, is firstly reported from China.

Tagesoidea tages Westwood, 1859

Necroscia tages, Westwood, 1859: 152, pl. 18: 1.
Calvisia tages, Kirby, 1904: 370.
Tagesoidea tages Redtenbacher, 1908: 565.
  Brock, 1995: 93.
  Brock, 1999: 119, 180. [Illustration]
  Otte & Brock, 2005: 330.
  Mandal & Yadav, 2010: 20.
  Hennemann & Conle, 2013: 8.

Type: Holotype: ♀, India Orientali, no. 675 (UMO).

Other material examined: ♀, Xishuangbanna, Yunnan Province, China, 3.VI.1958, Zhang Yiran (IZCAS).

Diagnosis: This species is related to *Tagesoidea nigrofasciata* Redtenbacher, 1908 [Borneo, and Malay Peninsula, Malaysia and Sumatra, Indonesia], but can be separated by its smooth thorax and black and white anal region of alae with pale white spots.

Notes: Known only from a single female (Fig. 7) which was collected from Xishuangbanna, Yunnan, southwestern China.

Distribution: Yunnan (Xishuangbanna), China. Also India (Assam) [Type locality] and Malaysia (Perak, Malay Peninsula).

ACKNOWLEDGMENTS

I wish to thank Mr Paul Brock (National History Museum, London, UK) for sending requested references and Dr Olivier Zompro for reviewing the manuscript. I also wish to thank the Institute of Zoology, Chinese Academy of Sciences (IZCAS) for giving access to the corresponding collection. I also deeply thank Prof Yang Xingke, Dr Yao Jian, Dr Liu Hong, Dr Bai Ming, Dr Ge Siqin and Miss Hu Xiaoyan (IZCAS) for their kind assistance. The author also wishes to thank the authority of the Damingshan Nature Reserve, Guangxi for permission to collect insects in the nature reserve and their staffs for their kind help.

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Figures and Tables

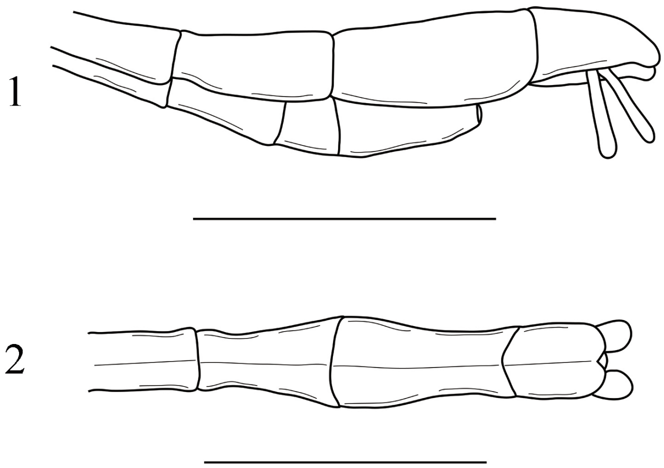

Figure 1–2. Male *Necroscia robustior* (Redtenbacher, 1908) [scale bar 5 mm]. 1. Male, end of abdomen, lateral view. 2. Male, end of abdomen, dorsal view. (Drawing by author)

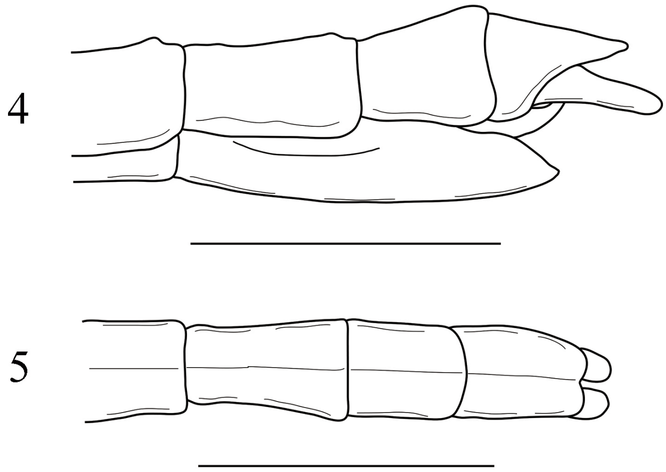

Figure 4–5. Female *Sosibia platycerca* Redtenbacher, 1908 [scale bar 5 mm]. 4. Female, end of abdomen, lateral view. 5. Female, end of abdomen, dorsal view. (Drawing by author)

Body part	Male *Necroscia robustior* (Redtenbacher, 1908)		Female *Sosibia platycerca* Redtenbacher, 1908	
	Length mm	Mean (n = 8)	Length mm	Mean (n = 3)
Body	64–70	67.2	59–66	62.7
Head	3	3	4	4
Antennae	65–78	73	40–49	43.7
Pronotum	3	3	4	4
Mesonotum	9–10	9.8	12–14	13
Metanotum incl. median segment	8.5–9.5	9.1	8	8
Profemora	22–24	23.2	12–13	12.3
Mesofemora	15–17	15.3	10–11	10.3
Metafemora	21–24	22	14–14.5	13.8
Protibiae	23–26	23.9	11–12	11.3
Mesotibiae	14–16	15.1	8–9	8.3
Metatibiae	22–27	23.6	14–15	14.3
Tegmina	5	5	3.5–4	3.8
Alae	35–39	36.8	24–25	24.3

Table 1. Measurements of male *Necroscia robustior* (Redtenbacher, 1908) and female *Sosibia platycerca* Redtenbacher, 1908.

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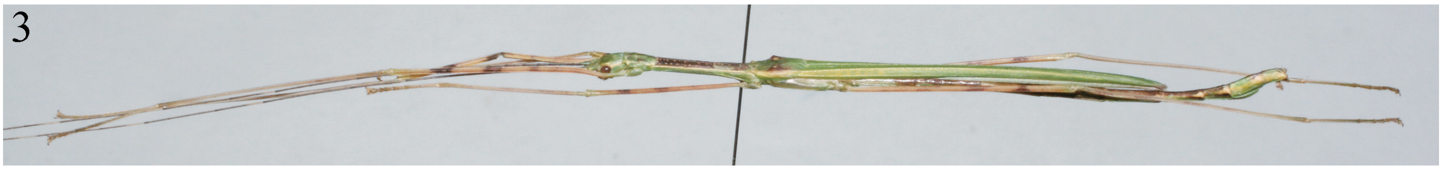

Figure 3. Habitus of male *Necroscia robustior* (Redtenbacher, 1908) (Photo by author)

6

Figure 6. Habitus of female *Sosibia platycerca* Redtenbacher, 1908 (Photo by author)

7

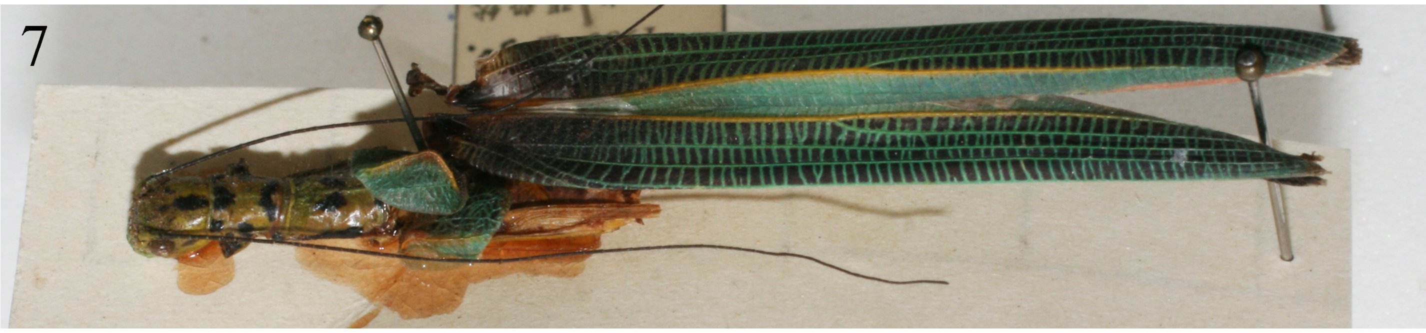

Figure 7. Habitus of female *Tagesoidea tages* Westwood, 1859 (Photo by author)

Conserving Lepidoptera in the landscape: present and future problems and perspective

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ABSTRACT

Major current efforts for conservation of moths and butterflies focus mainly on assuring adequate representation of major biotopes in protected areas, and on the management and restoration of sites and resources to restore or preserve taxa within their historically documented ranges. Most emanate from concerns for single species, and their conservation on sites (many of them small) subjected to a variety of external threats. The strong emphasis on butterflies and almost total neglect of many groups of moths is a legacy of historical interest and of the biological and distributional information available.

However, in addition to definable current threats, most of them associated with some aspect of habitat loss or degradation, climate changes introduce a variety of additional issues that demand wider landscape perspective and may render much current effort futile if this is not incorporated effectively into longer-term planning. It is thus important to consider options for expanding Lepidoptera conservation programmes to anticipate such changes and, if possible, preempt the vulnerability of relying on short-term effort by introducing longer-term considerations. Both practical and political difficulties are associated with any such expansion from current scope.

Major needs include increased attention to impacts of habitat/resource fragmentation, connectivity of places and other resources in landscapes, distributional shifts in relation to climate tolerances and impacts, and how protected areas may need to function in the future. Collectively, these dictate considerable (and in some cases controversial) changes from our predominant current perspectives, with increasing needs to also transcend political boundaries to promote landscape or range-wide conservation and plan for reserves that will be effective in the future. Some examples are briefly outlined and discussed.

Keywords
Butterflies, moths, habitat, critical resources, climate change, distribution

INTRODUCTION

The advance of Lepidoptera conservation at present focuses largely within conceptual and practical frameworks of:

(1) Responding to the crisis-management needs of individual declining (threatened) species, with priority given to those formally signaled as endangered, and thereby often eligible for wider 'official support', and for which legal obligation for conservation exists;
(2) A strong taxonomic bias to butterflies, reflecting their greater popularity and that the amount of background biological and distributional information exceeds that available for most moths, as a legacy of hobbyist/collector interests;
(3) A parallel bias toward parts of the northern temperate regions, with relatively small and well-documented faunas, and a strong tradition of natural history and conservation practice;
(4) Emphasis on sites or specific localities where the target taxa occur or have occurred in the past;
(5) A perspective of distribution mapping and population monitoring to determine trends and conservation status, needs and outcomes;
(6) Progressive attempts to ensure that representative examples of all key biotopes are included in protected areas.

These approaches (many of them exemplified in overviews such as that by Dover et al. 2011), have been fostered energetically by organisations such as Butterfly Conservation (Europe) and the Xerces Society (North America), and the novel ecological contributions from studies of many individually significant taxa, have led to wide appreciation of the needs for Lepidoptera conservation. They have also emphasised the complexity of management needed, that each ecologically specialised species will differ in its needs, and that combinations of field conservation and other approaches may be needed. Much of the practical need devolves on the twin themes of defining resource needs and understanding and ameliorating threats to these to ensure their continued availability, together with understanding population structure and dynamics of the species involved as critical in appraising accessibility of those resources.

However these perspectives are changing rapidly in both scale and scope, driven by the likely over-riding influences of climate change that potentially render much current conservation effort inadequate for the longer term. Lepidoptera conservation driven predominantly by sustaining the current perspectives may expose weaknesses in our approaches if these future needs are not anticipated, at least in part. These themes are discussed in this essay, to promote discussion and debate over how future planning for conservation of Lepidoptera (and, by extension, numerous other invertebrates) may be guided.

The dilemma falls into two major sectors – knowing what we have, and anticipating and planning what we have to do to keep it, with the latter tempered with considerable uncertainty over the outcome of actions we may elect to take. Understandably, the greatest concerns over the future of Lepidoptera have devolved on the small and well-documented butterfly faunas of northern temperate regions, for which historical interest has permitted clear assessment of changes in abundance and distribution of many taxa, and from which the science of butterfly conservation (and its more recent guided expansion to progressively encompass moths) became established. Those faunas have also been instrumental in displaying impacts of recent climate changes, most evidently through documented changes in distribution of well-monitored individual species, and compositional changes in wider assemblages as novel interactions between species occur. Discussing plans for developing butterfly conservation in Britain, Warren (1997) headed one paragraph 'The need to think big', in emphasising the need to plan for, and protect, large networks of natural habitats. 'Big' becomes 'bigger' (even 'gargantuan') if we adapt this principle of landscape connectivity to wider faunas and transcending political boundaries. The major compilation of 'Prime butterfly areas in Europe' (van Swaay and Warren 2003) has major importance in this perspective, as does the classic early warning of climate change impacts given by Dennis (1993) in a book that anticipated much of the more recent debate. Much recent ecological and conservation interest has focused on species on the edge of their range, with those edges changing in position and where populations are inherently less stable than in more central parts of their distributions. In many cases, this situation is apparently due to climatic tolerances and change: see discussion by Kuchlein and Ellis (1997), in which changes in numerous Microlepidoptera in the Netherlands are discussed.

As a basis for considering what changes might be needed in conservation practice and priority to encompass such wider changes, three main topics need to be appreciated clearly, together with the ways they are related functionally and can be used in planning. These topics, each complex and with burgeoning literature on their roles in conservation, are habitat, population structure, and impacts of climate change. They integrate to constitute a conservation basis grounded firmly in landscape ecology.

Habitat

Concepts of 'habitat' have developed considerably from the simple traditionally widespread definition of 'a place to live', and characterized by gross features of biotope or vegetation type, to focus more effectively on the resources needed by a species and how these are arranged in time and space as determinants of that species' existence and wellbeing. Following detailed appraisal by Dennis et al. (2003, 2007), a habitat can largely be defined for a species in terms of supply and accessibility of those 'critical resources'. They fall into two main categories.

The first category, 'Consumables', are those resources needed for food, with the requirements of caterpillars and adults differing considerably and not necessarily overlapping in the same place. They are usually amongst the best-known resources, as specific food plants for caterpillars or preferred nectar sources for adults, and are consequently those on which practical conservation has primarily focused. Most management plans for butterflies or moths include reference to enhancing or assuring supply of these, and site restoration commonly involves planting of such needed species. Both quantity and quality of consumables contribute to site favourability, enabling increased or sustainable carrying capacity and individual and population fitness.

Much more difficult to list and evaluate are the second category, 'Utilities', the wider environmental attributes that influence the normal behavioural repertoire of the species and its access to consumables. They include, as representative examples, oviposition and pupation sites, refuges for hibernation or aestivation, topography – such as slope and aspect of ground, and presence of bare ground (perhaps needed for basking or thermoregulation), territorial perches, perhaps along vegetation edges with nearby flyways for patrols and mate seeking, assembly sites, and many others in combinations peculiar to each individual species. Mutualistic taxa may be needed, such as specific host ants for many Lycaenidae, and may blur the distinction between utility and consumable resources through uncertainty over precise relationship or interaction (Pierce et al. 2002). Last, 'microclimate' is sometimes regarded as a separate resource category of 'Conditioner', with temperature a key determinant of distribution, activity, and how and when a species may develop or gain access to resources.

Places with resources are distributed in various ways within landscapes – from continuous or widespread to forming highly separated 'patches' within large areas in which some or all resources are absent. The traditional view of 'habitat' has thus largely been of tenable patches surrounded by a 'matrix' of inhospitable ground within which the species cannot thrive or, even, survive, and which may constitute a barrier to dispersal and prevent movement of individuals between patches. The greater emphasis on resources in defining habitat counters this considerably, without in any way diminishing the key importance of favourable habitat patches, in suggesting that some resources may be more widely dispersed, so that the matrix may contribute substantially to the species wellbeing. Matrix hospitality is assuming more central considerations in wider conservation management.

Population structure

In the past, a simplistic presumption of dichotomy of population structures guided much conservation consideration. Populations were regarded as either 'closed' (isolated demographic units governed largely by internal processes of births and deaths, without influence of migration, and thereby often vulnerable to changes of the localised sites on which they occurred) or 'open' (distributed more widely across landscapes but with each demographic unit affected by immigration and emigration, as well as by internal processes) (references in New 1997, Dover et al. 2011). The latter include many species that transcend narrow biotopes, to include the ecologically broader 'countryside specialists' of Pollard and Eversham 1995, see also Asher et al. 2001), but many of both major groups are highly specialised in their resource needs.

Studies of butterflies have been instrumental in changing this perspective, by founding the concept of 'metapopulations', as one of immense relevance in conservation assessment and management (Hanski 1999). Notable amongst the increasing variety of taxa studied, parallel long-term work on checkerspot butterflies in Europe and North America (summarised by Ehrlich and Hanski 2004) have helped to change the former perspective, in favour of more versatile processes whereby local extinctions on habitat patches constitute a phase of a normal sequence of repeated 'colonisation-extinction-recolonisation' events, with each such loss a normal component of population dynamics on this wider scale. A metapopulation thus comprises a number of more-or-less independent demographic units, each on a suitable habitat patch, and each of which is not necessarily 'permanent'; the entire system is sustained through dispersal or interchange of individuals, and any patch may or may not be inhabited at a given time whilst remaining part of the network through which the population is maintained. Spatial pattern and processes vary greatly, with Harrison (1994) suggesting three major arrangements. These are not wholly distinct, but convey the principles clearly, as (1) classical (a series of patches amongst which individuals disperse in either 'direction'); (2) mainland-island (in which large permanently occupied 'mainland' patches are sources of individuals that may disperse to smaller habitable 'islands' where populations might be formed, constituting a 'source-sink' system); and (3) patchy (with a large patchwork of habitat occupied by a number of 'spot' populations amongst which dispersal occurs within the bounded area). Extensive research has focused on the dynamics of Lepidoptera populations from this wider viewpoint, with metapopulation structures defined by approaches involving (1) evaluating the frequency of migrations among local populations; (2) determining the spatial pattern of populations within the landscape; and (3) analysing patterns of genetic variation and differentiation across populations. Metapopulation maintenance depends on connectivity (the level of accessibility by insects to habitat patches within a landscape), so that the proximity, size and condition of each patch is important, in addition to the condition of the terrain that separates them. Movements may be frequent or only very occasional, but each successful colonist arriving from elsewhere may provide for genetic refreshment of an existing population unit. It is sometimes unwise to categorise populations consistently across a whole species. Despite the attractions of stating that a given species manifests a particular kind of population structure, this is often a considerable over-simplification – as Thomas (2001) presciently noted from the diversity of scales at which populations are considered, 'we should seek a process-based framework for trying to understand population structure, rather than trying to force complex systems into descriptive categories they will rarely fit'. His studies on the Silver-spotted Skipper butterfly (*Hesperia comma* (L.)) in Britain demonstrated the relevance of spatial scale – whether, for example, a 'patch' (to or from which dispersal may occur) is delineated as a single food plant (a tuft of the grass *Festuca ovina* L.), or a continuous grassland area containing scattered suitable tufts and separated from other such areas. The various scenarios available could lead to the butterfly fitting several different structural population categories, with variation across the species' range and individual populations subject to different structuring processes. Thus, in his words, 'It is a waste of time to attempt to force any or all *H. comma* systems into a single population category' (Thomas 2001, p. 327). This species may not be unusual, but considerations of scale are universal in considering habitat isolation and management need in conservation and, where population structure is relevant, any such variation may need to be considered.

CLIMATE CHANGE

Climate regimes impose boundaries on habitat space and resource availability, and thresholds for insect life. In particular, temperature determines the range within which a given species can develop and thrive, and seasonal life-cycle patterns, associated also with availability of critical resources (Parmesan et al. 1999; Hill et al. 2002). With climate change, much of it comprising changes in temperature and precipitation regimes, such opportunities for many ecologically specialised insects are also changing, notably in distribution, patterns of seasonal development, links with critical consumable resources (which may respond to change in different ways and at different rates from the consumer), and the composition of local assemblages and communities. Such changes are potentially universal. Studies on butterflies, in particular, amongst the well-documented and relatively small faunas of the northern temperate regions have clearly revealed trends such as (1) northward extensions of range as conditions warm; (2) upward elevational shifts in distribution; and (3) range contractions from the southernmost or lowest elevation parts of documented historical ranges. The first two of these represent newly hospitable areas, for which rising temperatures enable colonisation should requisite resources be present, and the third represents conditions in which temperature may now be too warm for continued survival, or where colonisations by other taxa have imposed incompatible interactions.

DISCUSSION

The major implication of climate change is simply that many of the areas on which current conservation effort for Lepidoptera at present devolve may not be suitable for continued support of the focal species as conditions change. The three main options for any species can be summarised simplistically as (1) adapt to the changed conditions of climate, new species associations and changed community, and remain largely in the present occupied range; (2) disperse to track favourable regimes as these arise, changing distribution in response to those changes; or (3) if conditions become untenable and the species lacks adaptive capability, extinction. Many species of primary conservation concern are ecologically specialised, and may be committed to the third option.

Resource needs and population structure thus come together in appraising future conservation needs in relation to a species' possible responses to climate changes, and whether the species can still reach and use critical resources. They change the conservation perspective firmly from individual site to landscape scale issues, with considerations of dispersal capability and routes within largely anthropogenic landscapes, selection of possible future sites for conservation and attempting to secure these for an indefinite future, possibilities of need for some form of assisted colonisation, and gaining clear idea of priority needs in extending from current conservation management. A central component of planning is promotion of connectivity, with increasing attention to 'gradient habitats' that could facilitate species movements across the landscape, perhaps culminating in 'biodiversity corridors'. For Lepidoptera, the major gradients of interest are those that parallel temperature and so anticipate realistic trajectories of dispersal in response to warming, namely latitude and elevation. Proposals and suggestions range from national in scope (such as the recently-proposed National Wildlife Corridor Plan for Australia that 'lays the foundation for a new, collaborative, whole of landscape approach to biodiversity conservation' [draft released March 2012]) to numerous more local efforts to generally counter fragmentation of natural habitats. Construction and enhancement of habitat corridors is, for example, a core component of the long-running conservation campaign for the endemic Australian Richmond Birdwing butterfly (*Ornithoptera richmondia* (Gray)) in south eastern Queensland and northern New South Wales, where extensive planting of larval food plants can provide foci for oviposition by this strongly dispersing butterfly (Sands et al. 1997). Such efforts reflect wider advocacy for 'habitat networks' (see Samways 2007). Modelling to anticipate colonisation along habitat gradients may be a key feature in planning conservation of the resources needed, and securing sites for future occupation. As Dennis (1993) elegantly summarised 'populations persist when natality and immigration exceed mortality and emigration', with the opportunity for increase in any seasonal environment reflected in voltinism and tolerance to local conditions. Gradients in life history features are expected to occur within a normal range, and these may be influenced strongly by climate. Most Lepidoptera do not occupy all the distributional range that is apparently suitable for them. Whilst some species are indeed very widely distributed, most occupy rather limited ranges of latitude or elevation, even when their critical consumable resources are more widespread. Many such anomalies have not been explained convincingly, but sustaining seasonal and spatial synchrony with such resources is, clearly, vital.

With anthropogenic changes, the major trends of concern have been loss and alienation of natural habitats, in many landscapes transforming previously extensive areas of natural or seminatural vegetation, or low intensity traditional agricultural areas, to small fragments and more intensively changed production areas, respectively. The consequences are twofold: (1) absolute loss of much habitat area and resources, and (2) the remainder distributed as small, isolated fragments surrounded by more-or-less untenable matrix. Simplistically, small areas can support only smaller populations and lower species richness than larger areas, and may be more vulnerable to edge effects (such as invasions by alien species) and stochastic impacts. Conventionally interpreted, 'small and isolated' equates to increased vulnerability, with chances of interchanges of individuals (as genetic material) with other patches diminished and the progressively inbred residual populations perhaps enforcedly closed in structure.

Habitat fragmentation, in addition to being a primary conservation concern within a species' current range, is equally so for assessing colonisation potential in expanded ranges. Both community structure and species interactions may change markedly. The physical structure of the landscape, the distribution of critical resources in relation to the dispersal capability, and propensity of the species needing them, together shape the needs for conservation management. Many Lepidoptera are regarded as sedentary, flying or dispersing little and, so, with populations largely committed to persisting on currently occupied sites rather than naturally moving to disjunct patches elsewhere. Their biology may restrict range changes to gradual incremental creep along habitat gradients as additional bordering areas become tenable. Thus, the Golden Sun-moth (*Synemon plana* Walker, Castniidae) in south eastern Australia has mobile males and poorly flying females. Adults do not feed and are short-lived, and the moth occurs on remnant grassland patches; it is believed to have very low dispersal capability, and for assessing connectivity a 'working definition' of only 200 m separation between sites has been adopted as constituting isolation (references in New 2012). Again, however, generalisations are difficult to make. Many of the studies on distances travelled by butterflies and moths of conservation concern have been undertaken on rather small areas, whilst the areas really needed to evaluate dispersal distances may be much larger; for two burnet moths (Zygaenidae) in Sweden, Franzen and Nilsson (2007) suggested that at least 50 km^2 is needed. Interpretation can also be confounded by recent suggestions (Hovestadt et al. 2012) that different individuals may disperse in different ways to move between patches, with many simply following every–day movements, and others adopting a more distinctive dispersal mode.

Consideration of Lepidoptera conservation planning for the future thus requires (1) very careful consideration of the biology of the putative target species, if this level of focus is contemplated and (2) determining the condition and protection status of the landscape and related need for habitat restoration. The detail needed essentially precludes this level of treatment for any but the very highest priority species, but the generalities that emerge from considering the needs, based on current and possible future distribution patterns of currently range-restricted Lepidoptera may be instructive. Those distributions, treated very simplistically, comprise about five patterns of occurrence when considered along environmental gradients (New 2008, 2009): (1) populations only near the leading edge, such as alpine taxa occurring near the peaks of their possible elevational range, and with little option for further movements; (2) species found in the central range of gradient, seemingly with the 'flexibility' to move naturally in either direction, but usually with the factors bounding current range not wholly understood; (3) populations grouped more loosely over a wider range within a restricted region of the gradient, with options to concentrate or move, as above; (4) tightly grouped populations within such a restricted area, implying greater specialisation than last category, and possibly more vulnerable to changes; and (5) populations only near each end of the possible range, possibly reflecting extreme fragmentation or taxonomic confusion, perhaps with trailing edge populations having greater potential for change.

There is, of course, no certainty that any such range movements will occur, but the trends evident amongst northern hemisphere butterflies demonstrate their reality and scope (Parmesan et al. 1999), with poleward range shifts of up to 240 km reported. Dispersal behaviour at range edges has received considerable recent attention, and can be very complex, with some butterflies displaying several different dispersal modes (Conradt et al. 2000). However, colonisation success beyond current ranges reflects both behaviour and landscape ecology, with success diminishing with decreased connectivity as hospitable patches become more distant and so increasingly isolated. Availability of critical resources may limit success; for some Lepidoptera restricted by climate, suitable resources may already be available, and the need is 'simply' to reach them within a suitable regime, but for others those resources may be absent and so need to be provided. In providing for conservation to incorporate range changes with climate change, an idealistic scenario would be one in which (1) routes and rates of range expansion could be anticipated reliably; (2) future colonisation sites could be selected and secured well in advance of need; (3) those sites prepared to receive the critical resources needed by focal Lepidoptera species; and (4) later be colonised naturally by those species. In practice, none of this is likely to occur, as theoretically deficient, and both politically and practically unrealistic. Perhaps in particular, and reflecting inadequacies in present-day systems of protected areas, designation and protection of 'future reserves' will be extraordinarily difficult to achieve. Some progress may be fostered through existing and expanded covenanting systems that protect private lands from future despoliation and proffer some continued conservation. Deliberate recommendations of areas to be protected to cater for conservation of Lepidoptera against future climate changes are rare. In the Tianshan Mountains (China), the Glanville Fritillary, *Melitaea cinxia* (L.) occurs at the lower levels, whilst meadows at higher elevations (above 2050 m) have larval food plants but no butterflies. Zhou et al. (2012) emphasised the need to maintain these meadows as investment for the future, with a 'trade-off of present cost and future benefit', as potential habitat in response to global warming. However, the additional theme of 'assisted colonisation' or 'assisted migration' has received considerable recent attention for Lepidoptera, with Thomas (2011) considering it, involving translocations to newly suitable areas, to be the only real option to counter impacts of climate change for conservation of many narrow range endemic species unlikely to colonise new sites naturally across highly altered landscapes. Experimental trials to investigate whether populations can survive beyond their current species' climate range are still quite rare but have involved a number of butterfly taxa (Menendez et al. 2006), and others have probed whether sites broadly within the range of climatic suitability but beyond current distribution can be used. Assisted range expansions for two grassland butterflies, the Marbled White (*Melanargia galathea* (L.)) and the Small Skipper (*Thymelicus sylvestris* (Poda)) in northern England (Willis et al. 2009) involved moving several hundred adults of each, releasing them the day after capture in sites presumed to be climatically suitable but north of the current range. Numbers of individuals translocated by far exceeded those usually available for direct translocations, and populations were monitored annually during the flight season of each species. Both were still present eight years (generations) after being introduced, and populations had increased in distribution. In this example, costs of the assisted colonisation were minimal, largely because direct transfer obviated need for any captive breeding programme to build up numbers for this purpose (Willis et al. 2009).

More adventurous scenarios have also been advanced – for example, the possibility of re-establishing in Britain two species of butterflies widespread in Europe but which became extinct in Britain early in the twentieth century. Climatic modelling indicated that such assisted colonisation of the Black-veined White (*Aporia crataegi* (L.)) and the Mazarine Blue (*Polyommatus semiargus* (Rottemburg)), both of which are declining in Europe, might be viable (Carroll et al. 2009), and helpful also in indicating the suitability of Britain for other European taxa. Thomas (2011) later nominated the Provence Chalkhill Blue (*Polyommatus hispanus* (Herrich-Schaeffer)) and de Prunner's Ringlet (*Erebia triaria* de Prunner), both now threatened by climate changes further south in Europe, amongst a range of other non-British taxa as possible relocation candidates – but also emphasised that all such translocations should be within broad geographic regions, and that receptor sites should lack local endemics that might be susceptible to additional species being introduced. These contexts differ somewhat from dealing with threatened taxa present in only very small numbers as ecologically very specialised, for which considerable biological detail may be needed. The major needs fall into three broad categories; (1) characteristics of the species itself – risk, as possibility of extinction due to climate change within its current range, vagility, ecological role and resource needs; (2) candidate receptor sites – isolation, suitable position in landscape, actual or potential protection/security, levels of disturbance, species richness, presence of local endemics, wider conservation values; and (3) feasibility of the exercise – costs, logistic and public support (Hunter 2007). As McLachlan et al. (2007) warned, selection of the most deserving candidates for such intensive treatment will be difficult, and suggestions are likely to engender debate and delays. Assisted colonization, however, is only one of the options within a portfolio of conservation strategies available in response to climate-induced vulnerability, and the decisions involved in selecting the optimal one draw heavily on knowledge of the target species (Arribas et al. 2012).

The importance of conservation modules of interacting species (sensu Mouquet et al. 2005) is highlighted by possible differential responses of the constituent species to climate or other change. Populations within a species participate in two kinds of networks (Bergerot et al. 2010), namely (1) food webs within local communities and (2) local linkages amongst populations, as metapopulations, by dispersal. The recent concept of 'metacommunity' draws on both of these to emphasise local communities (including equivalents to modules) linked by dispersal of the interacting taxa and so leading to understanding how functional relationships may persist across a fragmented or otherwise changing landscape. Bergerot et al. discussed the example of a braconid parasite (*Cotesia glomerata* (L.)) and a host, the Large White butterfly (*Pieris brassicae* (L.)), to show that butterfly densities were not affected by habitat fragmentation along an urbanisation gradient in France, whereas parasitisation rate decreased strongly with increasing urbanisation. This difference was attributed to contrasted dispersal of the participants, as several km (*Pieris*) and only several hundred m (*Cotesia*). Parallels could be implied for almost any combination of interacting species across patchy landscapes, but both the colonisation in relation to climatic tolerances and the ability to track patchy resources in a changed range become important considerations in attempting to model or predict outcomes. Novel combinations may also arise – such as for the Brown Argus butterfly (*Aricia agestis* (Denis and Schiffermueller) in Britain, for which climatically facilitated northward spread has enabled it to increasingly use a widespread plant that was previously unused, as a new interspecific association that has facilitated rapid range spread (Pateman et al.2012).

The rich history of translocations and re-introductions of Lepidoptera provides many informative examples to consider, and emphasises the importance of careful documentation to aid understanding. Methods used vary considerably, from rather casual releases of adults to protected transfers of either wild-caught or captive-reared early stages for either soft or hard release. Thus, successful releases of the Atala butterfly (*Eumaeus atala*, once feared extinct in Florida) involved release of caterpillars in summer (when mortality was far less than in winter transfers), and covering these with netting to deter predation by ants (Smith 2002).

A theme of increasing importance in assisted colonisations induced by climate change is the potential preadaptations, and consequences of use, of stock from the various possible donor populations, where any selection may be possible. Genetic and behavioural ('performance') differences within a species distributed along an environmental gradient may not be well-known and, hypothetically, may be influential on the outcome. Equally hypothetically,, 'trailing edge populations' may be preferred for salvage as those most likely to be lost as ranges change, but might also be those least able to cope with the new leading edge extreme conditions. Expediently, the largest available donor population, irrespective of other considerations, may be preferred. A further option is to artificially increase the number of viable populations within the current range, anticipating genetic enhancement through this and so providing a more varied array of sources for further use, possibly leading to increased chances of introductions from multiple sources and 'hybrid vigour'.

At present, as noted above, such 'future planned translocations' are unlikely to appear on most conservation agendas for Lepidoptera (New 2008). However, with clear potential limitations to continuing to rely on current management perspectives, these additional approaches deserve serious and urgent debate and discussion in the face of the largely undocumented environmental changes so widely anticipated. Lepidoptera are one of the very few groups of invertebrates for which sufficient conservation background is available to incorporate them meaningfully in considering how conservation practice should change over the next few decades, and in which ideas that at present appear tangential, even outlandish, will necessarily gain currency.

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A Brief Summary of Tribe Cochylini from China (Lepidoptera: Tortricidae: Tortricinae)

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ABSTRACT

The status of the tribe Cochylini in China is briefly introduced. A list of the described Chinese Cochylini species is provided, along with a map to show the species richness in each province of China.

Keywords: Lepidoptera, Tortricidae, Cochylini, taxonomy, list, species richness, China

INTRODUCTION

The tribe Cochylini belongs to the subfamily Tortricinae in the family Tortricidae. Cochylini was erected by Guenée in 1845 for the type genus *Cochylis* Treitschke, 1829. Currently, 79 genera are described worldwide, of which 11 genera are recorded in China. The vast majority of species in this tribe are significant pests of crops, fruit and forest trees, with important economic significance in agroforestry.

The aim of the present paper is to give a brief summary of the tribe Cochylini from China, and to list the described Chinese Cochylini species to show the distribution data.

MATERIAL AND METHODS

This study is based on the examination of specimens deposited in the Insect Collection, College of Life Sciences, Nankai University (NKUM) and the related literature. The map was made using DIVA−GIS 7.5.0 software (Hijmans et al., 2011) and was subsequently modified in Photoshop CS5.

DIAGNOSES

Adults are small to medium size. Sexual dimorphism in some genera is expressed in the forewing shape, which is narrower in male than in female. The forewing ground colour is mainly yellowish white, yellow, yellowish brown or ochreous yellow, mostly with obliquely inward median fascia and subapical fascia, with basal blotch or pretornal spot in some genera. The male genitalia are characterised by the uncus degenerated in the majority of genera, the socius developed, the gnathos degenerated, the slender or stout phallus bearing numerous cornuti. The female genitalia are characterised by the ductusbursae not conspicuously differentiated from the corpus bursae, the antrum almost always heavily sclerotised, the corpus bursae with numerous spines and different shapes of sclerites.

TAXONOMIC SUMMARY

The tribe Cochylini is reviewed in China, with 11 genera and 101 valid species treated. Here, we give a brief introduction to the 11 genera that have been recorded in China.

The genus *Aethes* Billberg, 1820 can be easily distinguished by the erect and slender socius. It consists of 127 species worldwide, distributed mainly in the Holarctic Region, 16 of which have been reported to occur in China. We have further identified three species new to science and one species new for China (to be published separately).

The genus *Cochylidia* Obraztsov, 1956 is characterised by the erect costal arm of the valva with tiny distal spines. It consists of 11 valid species divided into two groups, occurring in the Palearctic and Oriental regions. Ten species have been recorded in China.

The genus *Cochylimorpha* Razowski, 1959 can be easily distinguished by having a broad valva and a short median process of transtilla. Some 95 described species of *Cochylimorpha* are distributed worldwide, mainly in the Oriental and Palearctic regions. On the basis of 23 previously recorded species in China, we add one new species to the world fauna and three new records for the Chinese fauna (to be published in another paper).

The genus *Cochylis* Treitschke, 1829 currently consists of 72 species that are distributed in the Holarctic, Oriental and Neotropical regions, 11 of which are recorded in China. The typical characters of this genus are the slender median process of transtilla, the narrow valva, and the developed and heavily sclerotisedantrum.

The genus *Eugnosta* Hübner, [1825]1816 is characterised by its erect and slender socius. It consists of 76 species worldwide, distributed mainly in the Palearctic, Nearctic and Neotropical regions. Besides the five previously recorded species in China, we have found one as yet undescribed species.

The genus *Eupoecilia* Stephens, 1829 can be easily distinguished by the drooped and crossed socius, the phallus bearing numerous spines, the ductusbursae with tiny spines and wrinkles, and the corpus bursae having spines and sclerites. It currently includes 37 described species, 29 of which are reported from the Oriental and Palearctic regions, and seven are recorded to occur in China. We have identified two species new to science and one newlyrecorded species for China (to be published separately).

The genus *Falseuncaria* Obraztsov & Swatschek, 1958 is characterised by the elongated tegumen, the cornutus composed of a bundle of spines, and the slender ductusbursae. Currently, seven described *Falseuncaria* species are distributed in the Holarctic and African regions, and five of them are distributed in China.

The genus *Gynnidomorpha* Turner, 1916 includes 16 species that are described from the Holarctic, Oriental, and Australian regions, with the highest species richness in the Palearctic Region. The main characters of this genus include the elongated tegumen curved orthogonally and the corpus bursae with an incomplete ring composed of spines. Nine species were recorded in China prior to this study. We have identified one new species to science and one newly recorded species from China (to be published separately).

The genus *Phalonidia* Le Marchand, 1933 can be easily distinguished by the socius fused basally and separated distally, and the developed antrum. Some 103 species are described from the Holarctic and Neotropical regions, 12 of which are reported to occur in China. We have identified three new species to science and three new records for China (to be published separately).

The genus *Phtheochroa* Stephens, 1829 is characterised by the slender uncus. It contains 110 described species, distributed worldwide, with only two species reported in China. During our study, we have identified two new species for China (to be published separately).

The genus *Thyraylia*Walsingham, 1897 can be easily distinguished by the presence of the uncus and the slender median process of the transtilla. *Thyraylia* consists of seven species worldwide, distributed mainly in the Holarctic Region. One species has been recorded in China.

SPECIES RICHNESS

Members of the tribe Cochylini are distributed in every Chinese province. The abbreviations of each province are listed in Table 1. Figure 1 shows the Cochylini species richness for each province (inclusive of the unpublished species). The distribution data of all the Cochylini species in China are based on the specimens deposited in the Insect Collection, College of Life Sciences, Nankai University (NKUM) and the related literature (Razowski, 1970; Diakonoff, 1984; Bai et al., 1996; Liu and Li, 2002; Byun and Li, 2006; Razowski, 2006; Sun and Li 2012a, 2012b; Sun and Li, 2013). Species richness in China is relatively higher in the north than in the south. According to the specimens collected in recent years, we speculate that there are still some Cochylini species awaiting to be identified in China.

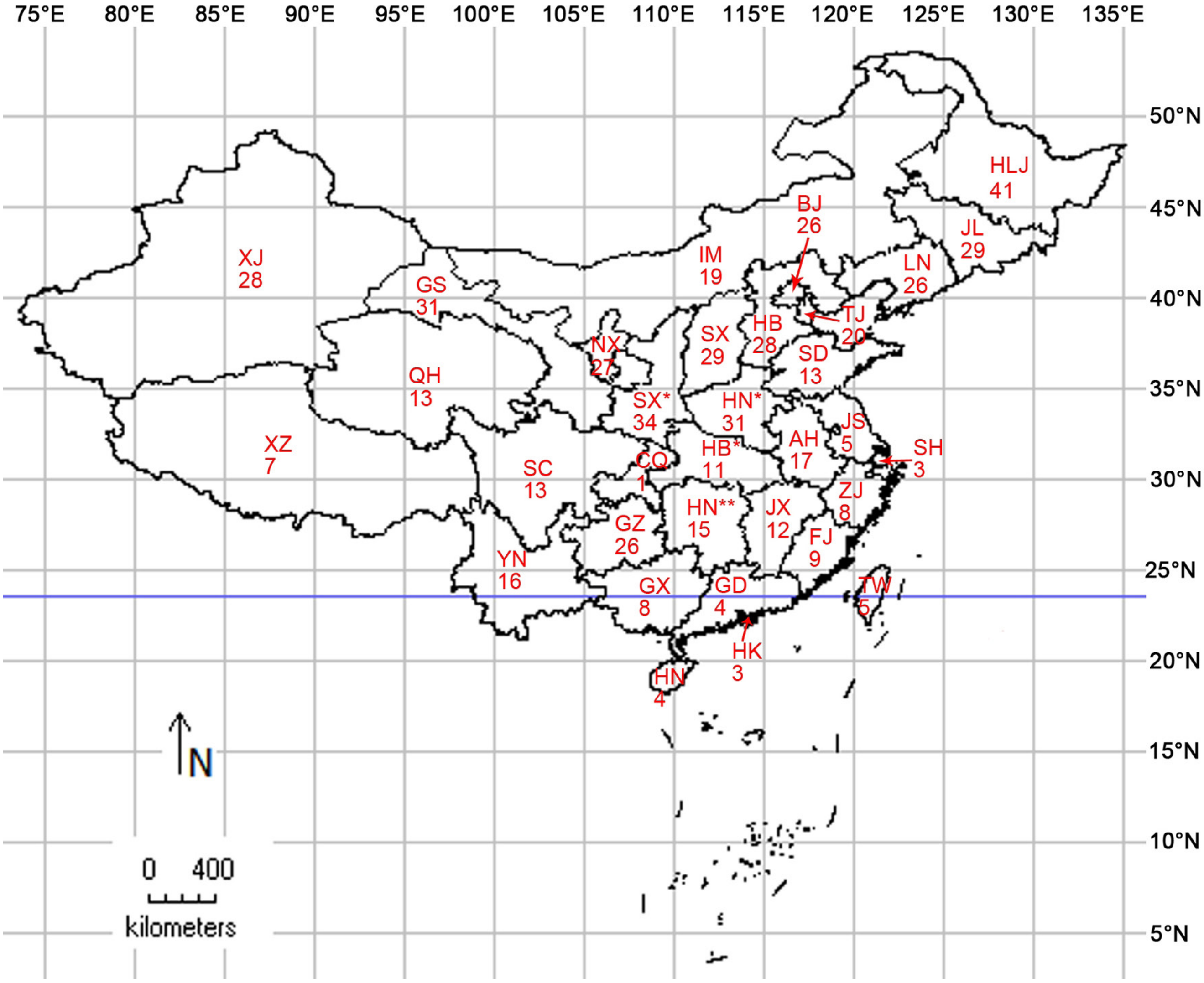

Figure 1. The species number of tribe Cochylini in each province of China

Provincial abbreviations		
AH – Anhui	HLJ – Heilongjiang	SC – Sichuan
BJ – Beijing	HN – Hainan	SD – Shandong
CQ – Chongqing	HN* – Henan	SH – Shanghai
FJ – Fujian	HN** – Hunan	SX – Shanxi
GD – Guangdong	IM – Inner Mongolia	SX* – Shaanxi
GS – Gansu	JL – Jilin	TJ – Tianjin
GX – Guangxi	JS – Jiangsu	TW – Taiwan
GZ – Guizhou	JX – Jiangxi	XJ – Xinjiang
HB – Hebei	LN – Liaoning	XZ – Xizang
HB* – Hubei	NX – Ningxia	YN – Yunnan
HK – Hongkong	QH – Qinghai	ZJ – Zhejiang

Table 1. Abbreviation of each province

LIST OF VALID COCHYLINI SPECIES IN CHINA

1. *Aethes alatavica* (Danilevskij, 1962)
Distribution: China (Beijing, Inner Mongolia, Ningxia, Qinghai, Shaanxi, Shanxi, Xinjiang), Russia.

2. *Aethes amurensis* Razowski, 1964
Distribution: China (Beijing, Gansu, Guizhou, Hebei, Heilongjiang, Henan, Jilin, Liaoning, Ningxia, Qinghai, Shaanxi, Shanxi), Korea, Russia.

3. *Aethes cnicana* (Westwood, 1854)
Distribution: China (Beijing, Heilongjiang, Inner Mongolia, Jilin, Liaoning, Tianjin), Japan, Korea, Russia, Europe.

4. *Aethes delotypa* Razowski, 1970
Distribution: China (Xizang, Yunnan), Europe.

5. *Aethes hoenei* Razowski, 1964
Distribution: China (Hunan, Jiangxi, Liaoning, Shaanxi, Zhejiang).

6. *Aethes mesomelana* (Walker, 1863)
Distribution: China (Heilongjiang, Hubei, Liaoning, Shanghai), Russia.

7. *Aethes moribundana* (Staudinger, 1859)
Distribution: China (Hebei, Inner Mongolia, Qinghai, Xinjiang), Afghanistan, Iran, Russia, Europe.

8. *Aethes rectilineana* (Caradja, 1939)
Distribution: China (Gansu, Heilongjiang, Henan, Hubei, Jiangsu, Shandong, Shanxi, Xinjiang, Zhejiang), Japan, Korea, Mongolia, Russia.

9. *Aethes rubigana* (Treitschke, 1830)
Distribution: China (Beijing, Hebei, Heilongjiang, Jilin, Liaoning, Ningxia), Japan, Russia, Europe.

10. *Aethes triangulana excellentana* (Christoph, 1881)
Distribution: China (Heilongjiang, Henan), Japan, Russia.

11. *Aethes atmospila* (Meyrick, 1937)
Distribution: China (Xinjiang, Yunnan).
12. *Aethes cinereoviridana* (Kennel, 1899)
Distribution: China (Xinjiang), central Asia.

13. *Aethes citreoflava* Kuznetzov, 1966
Distribution: China (Heilongjiang, Jilin), Japan, Korea, Russia, Mongolia.

14. *Aethes pardaliana* (Kennel, 1899)
Distribution: China (Xinjiang), Afghanistan, Russia.

15. *Aethes furvescens* Bai, Guo & Guo, 1996
Distribution: China (Shanxi).

16. *Aethes bistigmatus* Byun & Li, 2006
Distribution: China (Jilin), Korea.

17. *Cochylidiaaltivaga*Diakonoff, 1976
Distribution: China (Gansu, Sichuan, Taiwan), Nepal.

18. *Cochylidia contumescens* (Meyrick, 1931)
Distribution: China (Anhui, Guangxi, Henan, Tianjin), Japan, Korea, Russia.

19. *Cochylidia oblonga* Liu & Ge, 2012
Distribution: China (Anhui, Fujian, Gansu, Guangdong, Guangxi, Henan, Hubei, Hunan, Jiangxi, Liaoning, Tianjin).

20. *Cochylidia heydeniana* (Herrich-Schäffer, 1851)
Distribution: China (Xinjiang), Korea, Japan, Mongolia, Russia, Europe.

21. *Cochylidiaimplicitana* (Wocke, 1856)
Distribution: China (Xinjiang), Iran, Europe.

22. ***Cochylidiamoguntiana*** **(Rössler, 1864)**
Distribution: China (Anhui, Beijing, Fujian, Gansu, Guizhou, Hebei, Heilongjiang, Henan, Hunan, Inner Mongolia, Liaoning, Ningxia, Shaanxi, Shandong, Shanxi, Sichuan, Tianjin), Afghanistan, Iran, Korea, Russia, Europe.

23. ***Cochylidiamultispinalis*** **Sun & Li, 2012**
Distribution: China (Anhui, Gansu, Guangdong, Guangxi, Guizhou, Hebei, Heilongjiang, Hunan, Sichuan).

24. ***Cochylidia richteriana*** **(Fischer von Röslerstamm, 1837)**
Distribution: China (Beijing, Hebei, Heilongjiang, Hunan, Inner Mongolia, Liaoning, Ningxia, Qinghai, Shandong, Shanxi, Sichuan, Tianjin), Japan, Korea, Mongolia, Russia, Europe.

25. ***Cochylidia liui*** **Sun & Li, 2012**
Distribution: China (Guizhou).

26. ***Cochylidia subroseanaroseotincta*** **(Razowski, 1960)**
Distribution: China (Anhui, Hebei, Heilongjiang, Henan, Hunan, Jilin, Shanxi, Tianjin) , Europe, Japan, Korea, Russia.

27. ***Cochylimorpha asiana*** **(Kennel, 1899)**
Distribution: China (Beijing, Gansu, Hebei, Heilongjiang, Ningxia, Qinghai, Shaanxi, Shandong), Afghanistan, Iran, Mongolia, Russia, Libya.

28. ***Cochylimorpha conankinensis*** **(Ge, 1992)**
Distribution: China (Gansu, Shaanxi, Sichuan).

29. ***Cochylimorpha cultana*** **(Lederer, 1855)**
Distribution: China (Gansu, Jilin, Ningxia, Qinghai, Shaanxi, Shandong, Shanxi), Russia, Europe.

30. ***Cochylimorpha cuspidata*** **(Ge, 1992)**
Distribution: China (Anhui, Beijing, Gansu, Hebei, Heilongjiang, Henan, Hubei, Inner Mongolia, Liaoning, Ningxia, Shaanxi, Shanxi, Tianjin), Korea.

31. ***Cochylimorpha emiliana*** **(Kennel, 1919)**
Distribution: China (Heilongjiang, Qinghai), Mongolia, Russia.

32. ***Cochylimorpha fuscimacula*** **(Falkovitsh, 1963)**
Distribution: China (Shaanxi, Xinjiang), Russia.

33. ***Cochylimorpha hapala*** **(Diakonoff, 1984)**
Distribution: China (Hongkong), Borneo.

34. ***Cochylimorpha hedemanniana*** **(Snellen, 1883)**
Distribution: China (Anhui, Beijing, Hebei, Heilongjiang, Henan, Hubei, Jiangsu, Liaoning, Ningxia, Shaanxi, Shandong, Shanxi, Tianjin, Yunnan), Japan, Korea, Russia.

35. ***Cochylimorpha jaculana*** **(Snellen, 1883)**
Distribution: China (Anhui, Beijing, Hebei, Heilongjiang, Inner Mongolia, Jilin, Ningxia, Shaanxi, Shandong, Shanxi, Sichuan, Tianjin, Yunnan) , Japan, Korea, Mongolia.

36. ***Cochylimorpha lungtangensis*** **(Razowski, 1964)**
Distribution: China (Gansu, Guizhou, Hebei, Henan, Jiangsu, Liaoning, Ningxia, Qinghai, Shaanxi, Shanxi, Sichuan, Tianjin).

37. ***Cochylimorpha maleropa*** **(Meyrick, 1937)**
Distribution: China (Shaanxi, Yunnan).

38. ***Cochylimorpha nankinensis*** **(Razowski, 1964)**
Distribution: China (Guangxi, Henan, Hongkong, Hubei, Jiangsu, Shaanxi, Tianjin, Zhejiang), Korea.

39. ***Cochylimorpha perturbatana*** **(Kennel, 1900)**
Distribution: China (Xinjiang), Russia.

40. ***Cochylimorpha razowskiana*** **Kuznetzov, 2005**
Distribution: China (Beijing, Gansu, Hebei, Henan, Ningxia, Qinghai, Shanxi, Shaanxi), Russia.

41. ***Cochylimorpha gracilens*** **(Ge, 1992)**
Distribution: China (Xizang).

42. ***Cochylimorpha nipponana*** **(Razowski, 1977)**
Distribution: China (Heilongjiang, Shaanxi), Japan.

43. ***Cochylimorpha nomadana*** **(Erschoff, 1874)**
Distribution: China (Xinjiang) , Afghanistan, Iran, Russia.

44. ***Cochylimorphabipunctata*** **(BaiGuo&Guo, 1996)**
Distribution: China (Shanxi).

45. ***Cochylimorpha simplicis*** **(Bai Guo & Guo, 1996)**
Distribution: China (Shanxi).

46. ***Cochylimorpha amabilis*** **(Meyrick, 1931)**
Distribution: China (Xizang), Japan.

47. ***Cochylimorphaalticolana*** **(Razowski, 1964)**
Distribution: China (Xizang).

48. ***Cochylimorpha isocornutana*** **(Razowski, 1964)**
Distribution: China (Yunnan).

49. ***Cochylimorpha yangtseana*** **Razowski, 2006**
Distribution: China (Xizang).

50. ***Cochylis atricapitana*** **(Stephens, 1852)**
Distribution: China (Xinjiang), Europe.

51. ***Cochylis discerta*** **Razowski, 1970**
Distribution: China (Gansu, Inner Mongolia, Shanxi), Mongolia.

52. ***Cochylis defessana*** **Mann, 1861**
Distribution: China (Xinjiang) , Iran, Turkey.

53. ***Cochylis dubitana*** **(Hübner, [1799])**
Distribution: China (Heilongjiang), Europe.

54. ***Cochylis faustana*** **(Kennel, 1919)**
Distribution: China (Inner Mongolia, Xinjiang), Russia.

55. *Cochylis hybridella* (Hübner, [1813])
Distribution: China (Gansu, Guizhou, Heilongjiang, Inner Mongolia, Jilin, Liaoning, Ningxia, Shaanxi, Shanxi, Xinjiang), Japan, Korea, Russia, Europe.

56. *Cochylis piana* (Kennel, 1919)
Distribution: China (Inner Mongolia, Liaoning, Shaanxi, Xinjiang), Afghanistan, Iran, Russia.

57. *Cochylis roseana* (Haworth, [1811])
Distribution: China (Gansu), Iran, Russia, Europe.

58. *Cochylisposterana hyrcana* (Toll, 1948)
Distribution: China (Gansu, Xinjiang), Iran.

59. *Cochylis psychrasema* (Meyrick, 1937)
Distribution: China (Yunnan).

60. *Cochylistriangula* Sun & Li, 2013
Distribution: China (Guizhou, Yunnan).

61. *Eugnosta dives* (Butler, 1878)
Distribution: China (Heilongjiang, Inner Mongolia, Jiangsu, Jilin, Liaoning, Ningxia, Shaanxi, Shandong), Japan, Russia.

62. *Eugnosta fenestrana* Razowski, 1964
Distribution: China (Beijing, Jilin, Qinghai), Mongolia, Russia.

63. *Eugnosta hydrargyrana mongolica* Razowski, 1970
Distribution: China (Beijing, Heilongjiang, Shaanxi, Shandong), Mongolia.

64. *Eugnosta magnificana* (Rebel, 1914)
Distribution: China (Inner Mongolia), Afghanistan, Iran, Russia, Europe.

65. *Eugnosta romanovi* (Kennel, 1900)
Distribution: China (Xinjiang), Russia.

66. *Eupoecilia ambiguella* (Hübner, 1796)
Distribution: China (Anhui, Beijing, Chongqing, Hainan, Hebei, Heilongjiang, Henan, Hubei, Hunan, Fujian, Gansu, Guangdong, Guaingxi, Guizhou, Jiangxi, Liaoning, Ningxia, Shaanxi, Shanxi, Sichuan, Tianjin, Xinjiang, Yunnan, Zhejiang, Taiwan), India, Japan, Korea, Mongolia, Russia, Europe.

67. *Eupoecilia angustana* (Hübner, 1799)
Distribution: China (Anhui, Beijing, Gansu, Heilongjiang, Henan, Jilin, Ningxia, Shaanxi, Shandong, Shanxi), Japan, Korea, Russia, Europe.

68. *Eupoecilia citrinana* Razowski, 1960
Distribution: China (Beijing, Hebei, Heilongjiang, Henan, Hunan, Jilin, Shaanxi, Tianjin), Japan, Korea, Russia.

69. *Eupoeciliainouei*Kawabe, 1972
Distribution: China (Guizhou, Hebei, Henan, Hunan, Jiangxi, Jilin, Ningxia, Shaanxi, Shanxi), Japan, Korea, Russia.

70. *Eupoecilia kobeana* Razowski, 1968
Distribution: China (Guangxi, Guizhou, Henan, Hunan, Taiwan, Yunnan, Taiwan), Japan, Korea, Russia.

71. *Eupoecilia quinaspinalis* Zhang & Li, 2008
Distribution: China (Fujian, Hainan).

72. *Eupoecilia sanguisorbana* (Herrich-Schäffer, 1856)
Distribution: China (Hebei, Heilongjiang, Inner Mongolia), Europe.

73. *Falseuncaria brunnescens* Bai, Guo & Guo, 1996
Distribution: China (Shanxi).

74. *Falseuncaria degreyana* (McLachlan, 1869)
Distribution: China (Xinjiang), Mongolia, Russia, Europe.

75. *Falseuncariakaszabi*Razowski, 1966
Distribution: China (Gansu, Inner Mongolia, Ningxia, Qinghai, Shaanxi), Mongolia.

76. *Falseuncarialechriotoma*Razowski, 1970
Distribution: China (Hebei), Mongolia.

77. *Falseuncariaruficiliana* (Haworth, [1811])
Distribution: China (Xinjiang), Europe.

78. *Gynnidomorpha alismana* (Ragonot, 1883)
Distribution: China (Anhui, Fujian, Guangdong, Guizhou, Hebei, Heilongjiang, Hubei, Hunan, Inner Mongolia, Jiangxi, Jilin, Shaanxi, Yunnan), Korea, Europe.

79. *Gynnidomorphajulianiensis* (Liu & Ge, 1991)
Distribution: China (Guizhou, Hunan, Jiangxi).

80. *Gynnidomorpha luridana* (Gregson, 1870)
Distribution: China (Heilongjiang, Henan, Jilin, Liaoning), Japan, Korea, Turkey, Russia, Europe.

81. *Gynnidomorphamesotypa* (Rzaowski, 1970)
Distribution: China (Guizhou, Jiangsu, Shaanxi, Shanghai), Japan.

82. *Gynnidomorpha minimana* (Caradja, 1916)
Distribution: China (Hebei, Heilongjiang, Jiangxi, Jilin, Yunnan, Taiwan), Japan, Korea, Russia, Europe.

83. *Gynnidomorpha permixtana* [Denis & Schiffermüller, 1775]
Distribution: China (Anhui, Beijing, Fujian, Gansu, Guizhou, Hainan, Hebei, Heilongjiang, Henan, Hubei, Liaoning, Ningxia, Shaanxi, Shandong, Shanghai, Shanxi, Sichuan, Tianjin, Xizang, Zhejiang), Afghanistan, Iran, Japan, Korea, Mongolia, Russia, Europe.

84. *Gynnidomorpha pista* (Diakonoff, 1984)
Distribution: China (Anhui, Beijing, Fujian, Guangxi, Guizhou, Hainan, Hongkong, Liaoning, Tianjin).

85. *Gynnidomorpha vectisana* (Humphreys & Westwood, 1845)
Distribution: China (Henan, Jiangxi, Jilin, Xinjiang), Japan, Korea, Europe.

86. *Gynnidomorpha rubricana* (Peyerimhoff, 1877)
Distribution: China (Jilin), Europe.

87. *Phalonidiachlorolitha* (Meyrick, 1931)
Distribution: China (Gansu, Hebei, Heilongjiang, Henan, Hubei, Jilin, Liaoning, Ningxia, Shanxi, Sichuan, Zhejiang), Japan, Korea, Russia.

88. *Phalonidiacontractana* (Zeller, 1847)
Distribution: China (Henan, Xinjiang), Afghanistan, Iran, Lebanon, Pakistan, Russia, Europe.

89. *Phalonidia curvistrigana* (Stainton, 1859)
Distribution: China (Anhui, Beijing, Gansu, Guizhou, Heilongjiang, Shaanxi), Japan, Korea, Russia, Europe.

90. *Phalonidia fraterna* Razowski, 1970
Distribution: China (Heilongjiang, Henan), Korea, Russia.

91. *Phalonidialatifasciana*Razowski, 1970
Distribution: China (Jilin, Sichuan), Japan, Korea, Russia, Europe.

92. *Phalonidia lydiae* (Filipjev, 1940)
Distribution: China (Anhui, Beijing, Gansu, Guizhou, Heilongjiang, Hunan, Jilin, Liaoning, Ningxia, Yunnan), Japan, Korea, Russia.

93. *Phalonidiamelanothicta* (Meyrick, 1927)
Distribution: China (Anhui, Fujian, Guangxi, Guizhou, Hubei, Hunan, Jiangxi, Ningxia, Sichuan, Yunnan, Zhejiang), Japan.

94. *Phalonidianicotiana* Liu &Ge, 1991
Distribution: China (Heilongjiang, Liaoning).

95. *Phalonidiascabra* Liu &Ge, 1991
Distribution: China (Gansu, Guizhou, Heilongjiang, Jiangxi, Liaoning, Shanxi, Yunnan, Zhejiang), Korea.

96. *Phalonidiasilvestris*Kuznetzov, 1966
Distribution: China (Gansu, Heilongjiang, Henan, Hunan, Liaoning, Ningxia), Korea, Russia.

97. *Phalonidia zygota* Razowski, 1964
Distribution: China (Beijing, Gansu, Hebei, Heilongjiang, Inner Mongolia, Jilin, Qinghai, Shandong, Tianjin), Japan, Korea, Mongolia, Russia.

98. *Phalonidia dysodona* (Caradja, 1916)
Distribution: China (Heilongjiang), Russia.

99. *Phtheochroainopiana* (Haworth, [1811])
Distribution: China (Beijing, Gansu, Hebei, Heilongjiang, Jilin), Iran, Japan, Mongolia, Russia, Europe.

100. *Phtheochroa pistrinana* (Erschoff, 1877)
Distribution: China (Beijing, Jiangxi, Xizang, Gansu), Japan , Korea, Mongolia.

101. *Thyraylia nana* (Haworth, [1811])
Distribution: China (Hebei, Heilongjiang, Shanxi), Russia, Europe, North America.

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Global distribution and species richness of the genus *Promalactis* Meyrick, 1908 (Lepidoptera: Oecophoridae)

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ABSTRACT

The global distribution and species richness of the genus *Promalactis* Meyrick is summarised. China has the highest species richness of *Promalactis.* A distibution map of the genus in China is given.

Key words: Lepidoptera, Oecophoridae, *Promalactis*, distribution, species richness.

INTRODUCTION

The genus *Promalactis* was established by Meyrick (1908) with *P. holozona* Meyrick, 1908 from India as the type species. Adult *Promalactis* species can be easily identified by the smooth head with metallic luster and a pair of lanceolate forewings with various dark or white markings against yellow to dark ochreous brown ground colour.

The early taxonomic contributions to the genus were made by Meyrick from 1906 to 1937, who described 34 valid species. K. T. Park (Korea), A. L. Lvovsky (Russia) and S. X. Wang (China) have been engaged in the study of *Promalactis* in more recent years, with additional species identified and described. The aim of this paper is to summarise the distribution of *Promalactis* species worldwide.

DISTRIBUTION AND SPECIES RICHNESS

Promalactis Meyrick is a large Palaearctic and Oriental genus with 227 valid species, distributed in Brunei, Burma, China, India, Indonesia, Japan, Korea, Malaysia, Nepal, Philippines, Russia (Far East), Sri Lanka, Thailand, Vietnam and South Africa (Table 1, Fig. 1). *Promalactis suzukiella* (Matsumura, 1931) has recently been introduced into the United States (Adamski *et al*., 2009).

The Chinese fauna, crossing both Palaearctic and Oriental regions, has the highest number of *Promalactis* species, with 125 valid species recorded to date, distributed almost throughout the whole country except in Inner Mongolia, Ningxia Hui Autonomous Region, Xinjiang Uygur Autonomous Region and Macau (Fig. 2). Species richness of *Promalactis* Asia is also high in Southeast, with many species being recorded (Lvovsky, 2000; Kim *et al*., 2010, 2012; Wang, Du and Li, 2013). Among these, 22 species were reported to occur in Indonesia, 17 in Vietnam and 15 in Malaysia; less than 10 were recorded in Brunei, Burma, Philippines and Thailand. Twenty-one species were recorded from India by Meyrick (1906, 1908a, 1908b, 1914, 1915, 1918, 1919, 1920, 1922, 1923, 1930, 1937), but since then no species has been recorded from that country. In East Asia, more than 10 species were recorded

Country	Number of species	References
Brunei	8	Wang, Du & Li, 2013 (in press)
Burma	2	Meyrick, 1908b; Wang, Du & Li, 2013 (in press)
China	125	Wang, 2006; Wang, Kendrick& Sterling, 2009; Du, Li & Wang, 2011; Du, Wang & Li, 2013 (in press); Du & Wang, 2013 (in press)
India	21	Meyrick, 1906, 1908a, 1914, 1915, 1918, 1919, 1920, 1922, 1923, 1930, Meyrick, 1937; Clarke, 1963
Indonesia	22	Lvovsky, 2000a, 2000b; Wang, Du & Li, 2013 (in press)
Japan	12	Fujisawa, 2002
Korea	13	Park, 1981; Park & Park, 1998
Malaysia	15	Lvovsky, 2000a; Wang, Du & Li, 2013 (in press)
Nepal	3	Lvovsky, 2000a; Wang, Du & Li, 2013 (in press)
Philippines	4	Lvovsky, 2000a; Wang, Du & Li, 2013 (in press)
Sri Lanka	5	Meyrick, 1906, 1908a, 1918; Clarke, 1963
Thailand	8	Wang, Du & Li, 2013 (in press)
Vietnam	17	Lvovsky, 1988, 1997, 2007; Kim *et al*., 2010, 2012
Russia	10	Lvovsky, 1985, 1986
South Africa	5	Meyrick, 1913, 1914, 1918, 1937
USA	1	Adamskiet *al*., 2009

Table 1. Species richness of *Promalactis* in the world

in Japan (Fujisawa, 2002) and Korea (Park, 1981, 1998). Ten species have been recorded from Russia (Far East). In conclusion, the *Promalactis* species in the Oriental Region is richer than in the Eastern Palaearctic Region.

Promalactis species richness is the highest in China (Table 1). Some 105 species have been described based on the types collected from China, accounting for 47% of the known species worldwide. The species richness (Fig. 3) is higher in Zhejiang (35 species), Hubei (27 species), Henan (26 species), Fujian (24 species), Jiangxi (23 species), Hainan (21 species), Guizhou (21 species) andSichuan (20 species). Our collection shows that there are still more *Promalactis* species awaiting description in China.

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FIGURES

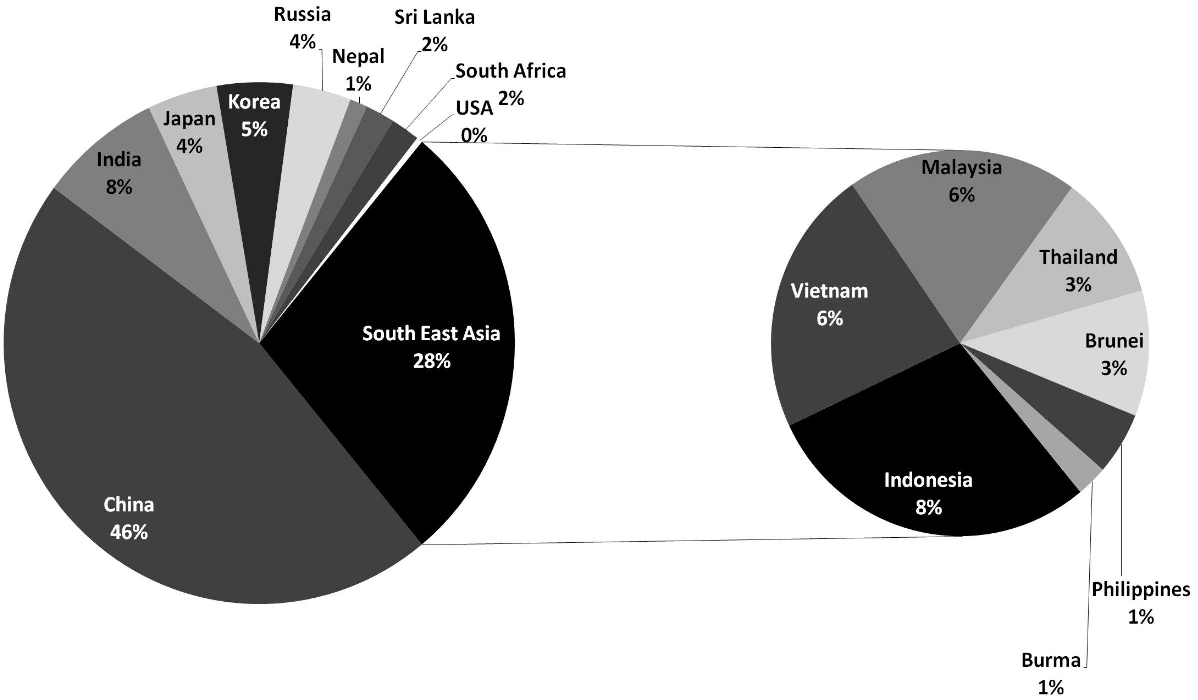

Fig. 1 World richness of *Promalactis* species

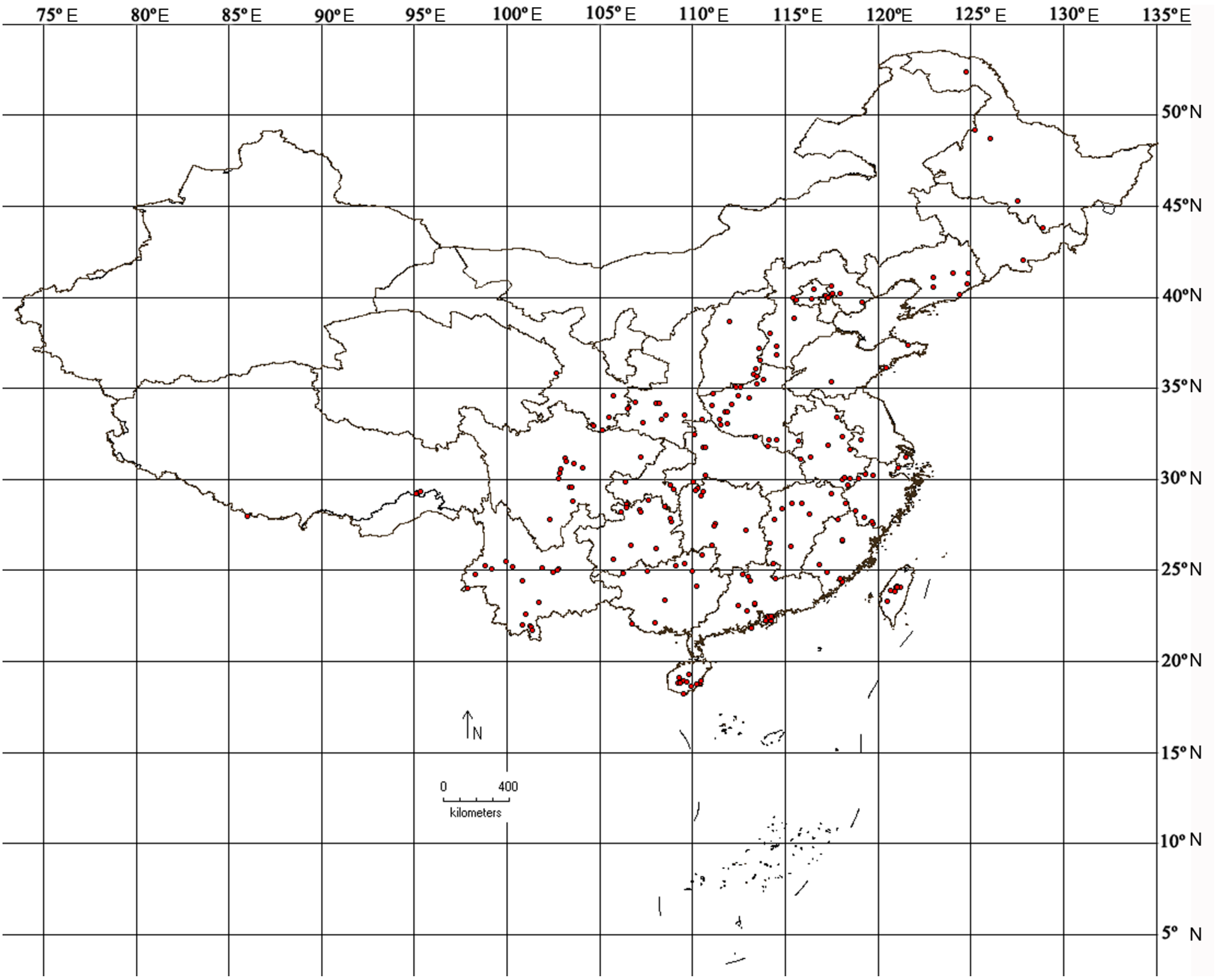

Fig. 2 Distribution of the genus *Promalactis* in China

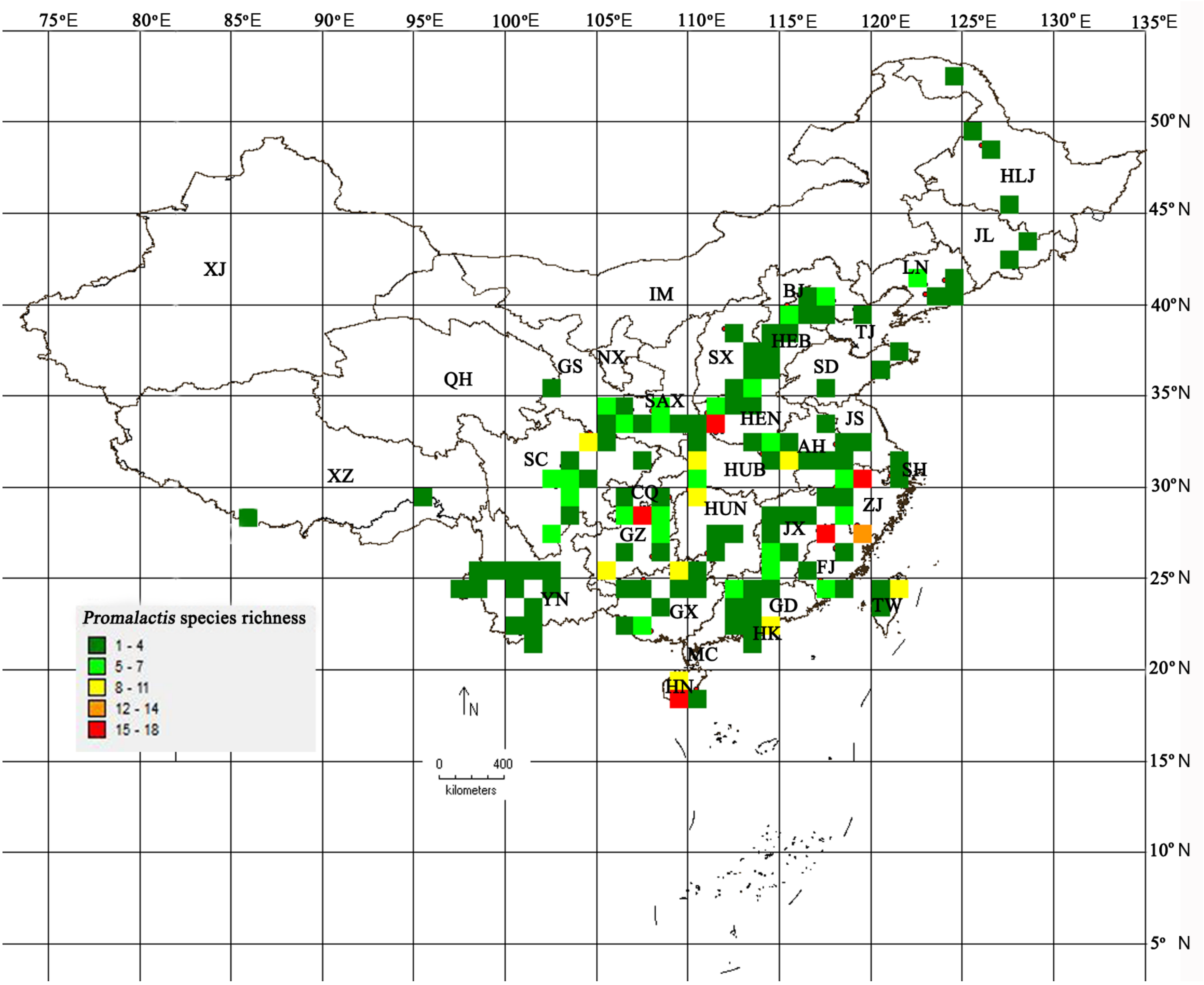

Fig. 3 *Promalactis* species richness in China

Notes: The geographic map was prepared using DIVA-GIS software. The Korean peninsula distribution of the genus follows Park (1981, 1998) and does not distinguish between North and South Korea.

Abbreviations of Provinces in China: BJ: Beijing; TJ: Tianjin; HEB: Hebei; SX: Shanxi; IM: Inner Mongolia; LN: Liaoning; JL: Jilin; HLJ: Heilongjiang; SH: Shanghai; JS: Jiangsu; ZJ: Zhejiang; AH: Anhui; FJ: Fujian; JX: Jiangxi; SD: Shandong; HEN: Henan; HUB: Hubei; HUN: Hunan; GD: Guangdong; GX: Guangxi; HN: Hainan; SC: Sichuan; GZ: Guizhou; YN: Yunnan; XZ: Xizang; SAX: Shaanxi; GS: Gansu; QH: Qinghai; NX: Ningxia; XJ: Xinjiang; TW: Taiwan; HK: Hong Kong; MC: Macau.


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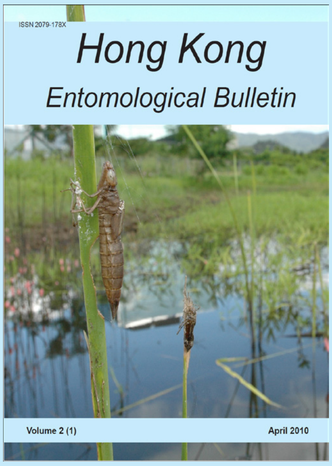
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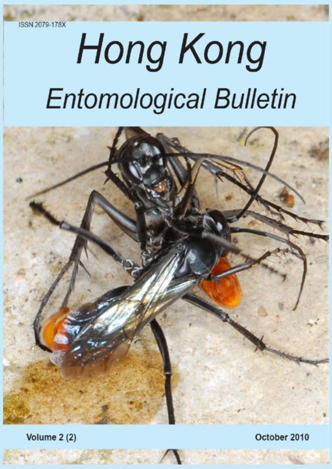
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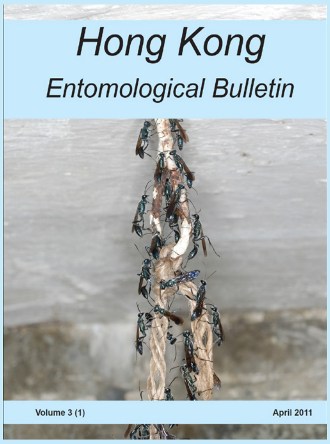
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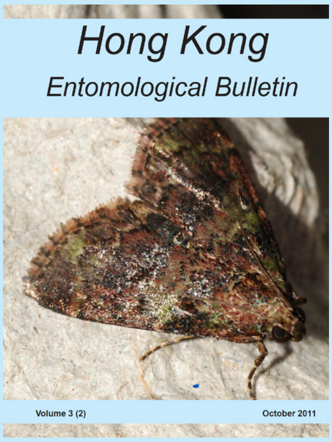
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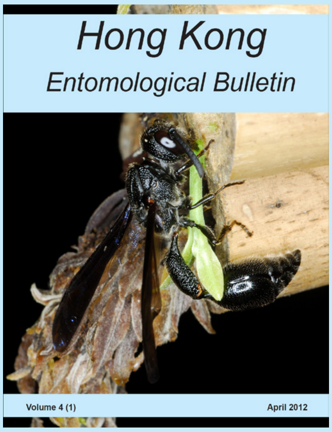
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