Notes on the Genus *Bactrocera* Fruit Fly species in Mango Orchards in Myanmar

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**Abstract:** Two surveys were conducted in the dry season and monsoon season by the Japan International Cooperation Agency (JICA) in 2014 to reveal the presence of the *Bactrocera* fruit fly species in Myanmar. In the survey, host fruit sampling and trapping were conducted at four major mango production areas, namely the Yangon, Bago and Mandalay regions and Shan State, and more than seventy thousand *Bactrocera* fruit fly specimens were collected in twenty mango orchards in nine townships. While results of the seasonal occurrence of serious quarantine pest species were previously reported, further analysis was made in this study to determine fruit fly fauna in mango orchards. Based on the morphological research, twenty *Bactocera* species were identified including major serious fruit flies such as *B. dorsalis*, *B. correcta* and *B. cucurbitae*. Out of the twenty species, nine were new findings and not recorded previously in Myanmar.

**Key words:** Dacinae, *Bactrocera*, Myanmar, attractant, quarantine, plant protection

**Introduction**

In recent years, some taxonomists have reported on the Dacinae fruit fly fauna of countries such as India, Bangladesh and China around Myanmar (Kapoor, 1993; Leblanc *et al.*, 2013, 2014; Fericia Kueh Tai Hui *et al.*., 2013; Drew *et al.*, 2007; Hardy, 1973; Liang *et al.*, 1993; Tsuruta and White; 2001, Tsuruta, 1998). According to Drew and Romig (2013), at least fourteen *Bactrocera* species seem to occur in Myanmar, but no significant information has been reported of *Bactrocera* fruit fly fauna in Myanmar. Two types of approaches, i.e. fruit sampling and adult fly trapping, were conducted by the Japan International Cooperation Agency (JICA) in 2014 in order to reveal the distribution of the pest fruit flies in mango orchards in Myanmar. While Nakahara *et al.* (2018) previously reported the seasonal occurrence information of serious plant quarantine pest species such as *B. correcta*, *B. dorsalis* and *B. cucurbitae*, this study summarizes all the species collected in the survey under the view of a fauna of the fruit flies, which is the first comprehensive report of fruit fly species occurring in mango orchards in Myanmar.

**Materials and methods**

Fruit fly specimens were collected from four major mango production areas, namely the Yangon, Bago and Mandalay regions and Shan State, using two methods, i.e. fruit sampling and adult fly trapping. The methods in detail and geographical data of the locations were described in detail in Nakahara *et al.* (2018). The specimens were kept in a dry state until observation. Morphological identification was made under a stereoscopic microscope. For observation of the terminalia, male abdomens were treated with 10% KOH and transferred to distilled water for dissection as needed. They were placed on double-sided tape and examined under a stereoscopic microscope. Wings were mounted on prepared slides using gum-chloral mounting media and the length was measured under stereoscopic a microscope. Each specimen was identified morphologically in the laboratories of the Plant Protection Division (PPD) in Insein, Yangon, and the Nagoya Plant Protection Station (NPPS) and Yokohama Plant Protection Station (YPPS) in Japan. The main references used for identification were White and Elson-Harris (1992), Drew and Romig (2013) and Drew and Romig (2016), while other papers were referred.

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to as needed. Several researchers suggested the elevation of the *Bactrocera* subgenus *Zeugodacus* to full genus level based on phylogenetic data in recent years (De Meyer et al., 2015; Doorenweerd et al., 2018; Krosch et al., 2012; Virgilio et al., 2015). However, Han et al. (2017) refers to weak statistical support based on poor sampling data, and that the view has not been accepted by some authors. We considered the status is in the middle of discussion and used the *Bactrocera* subgenus *Zeugodacus* in the study. The specimens examined are deposited in the Research Division of the Yokohama Plant Protection Station, Ministry of Agriculture, Forestry and Fisheries.

**Results and discussion**

In the fruit sampling, more than two thousand adult flies were detected from mango fruits. As a result of identification, three species were confirmed including *Bactrocera carambolae*, *B. correcta* and *B. dorsalis*. However, *B. zonata*, well known as a species infesting mangoes, was unexpectedly not detected from mango fruits in the survey. *B. latifrons*, not pest of mangoes, were detected from fresh chili (*Capsicum* sp.) cultivated on the premises of the PPD in Insein, Yangon. In the adult fly traps, more than seventy thousand adult males were collected by the trapping survey. As a result of morphological observation, nineteen species were detected as follows: *Bactrocera asiadacus* apicalis, *B. (Bactrocera) bhutaniae*, *B. (Bactrocera) carambolae*, *B. (Bactrocera) correcta*, *B. (Bactrocera) dorsalis*, *B. (Bactrocera) nigrifacia*, *B. (Bactrocera) rubigina*, *B. (Bactrocera) sp. near lateritaenia*, *B. (Bactrocera) tuberculata*, *B. (Bactrocera) zonata*, *B. (Parasinodacus) cilifera*, *B. (Parasinodacus) incisa*, *B. (Sinodacus) hochii*, *B. (Sinodacus) sp. near laterum*, *B. (Zeugodacus) caudata*, *B. (Zeugodacus) cucurbitae*, *B. (Zeugodacus) diversa*, *B. (Zeugodacus) isolata*, *B. (Zeugodacus) tau* (refer to Fig 1, Fig 2, Table 1 and Fruit flies recorded in the present study (described below)).

According to previous reports, fourteen *Bactrocera* species are occurring in Myanmar (CABI, 2017; Drew and Romig, 2013). Out of these species, nine species were confirmed in our survey, and the other five species (data not shown) were not detected. In addition to those nine species, eleven other species were confirmed in our survey. Among the species, two species, *B. sp. near lateritaenia* and *B. sp. near laterum*, could not be identified exactly because there were few samples and a sufficient analysis could not be conducted. Although not described in detail in this paper, another *B. sp* was also recorded in addition to the two species. Further investigation is necessary about the three species using more specimens. For the other nine species, namely *B. apicalis*, *B. bhutaniae*, *B. carambolae*, *B. cilifera*, *B. diversa*, *B. hochii*, *B. isolate*, *B. nigrifacia* and *B. rubigina*, it would be the first time for a scientific journal to report their distribution in Myanmar.

Seven species, namely *B. carambolae*, *B. correcta*, *B. dorsalis*, *B. tuberculata*, *B. zonata*, *B. cilifera* and *B. cucurbitae*, were detected in all research area regardless of altitude, suggesting widespread distribution in mango cultivation areas. Five species, namely *B. apicalis*, *B. diversa*, *B. hochii*, *B. sp. near lateritaenia* and *B. sp. near laterum*, were detected in the Yangon and/or Bago regions only. Three species, namely *B. incisa*, *B. isolata* and *B. bhutaniae*, were detected in Mandalay and Shan State only respectively. In addition, three species, namely *B. caudate*, *B. rubigina* and *B. tau*, were not detected in Shan State. A probable reason is that their habitat depends on host plants and the surrounding environment of mango orchards. This survey was carried out largely in mango orchards and the surrounding area. However, twenty species were found despite the limited research area, suggesting a diversity of fruit fly fauna in Myanmar. This survey should contribute to advancing studies on fruit flies because there is little information on fruit flies in Myanmar.

**Fruit flies recorded in the present study**

*Bactrocera (Asiadacus) apicalis* (de Meijere) (Fig 1: 1)

Distribution: Brunei, China, Malaysia, Thailand, Vietnam and Indonesia (Drew and Romig, 2013). Attractant: cue-lure. Host: *Trichosanthes wawraei* flowers (*Cucurbitaceae*) (Allwood et al., 1999). This is probably the first record in Myanmar.

*Bactrocera (Bactrocera) bhutaniae* (Fig 1: 2)

Distribution: Bhutan, India, Bangladesh, Vietnam, Thailand and Taiwan (Doorenweerd et al., 2018; Drew and Romig, 2013). Attractant: cue-lure. Host: *Xylosma brachystachys* (*Flacortiaceae*) (Drew and Romig, 2013). Doorenweerd et al. (2019) doubts the plant name based on the fact that it is unresolved in Theplantlist.org (2017). This is probably the first record in Myanmar.

*Bactrocera (Bactrocera) carambolae* Drew & Hancock (Fig 1: 3)

Distribution: India, Indonesia, Malaysia, Thailand, and Vietnam. Introduced into French Guiana, Guyana and Suriname (Drew and Romig, 2013). Attractant: methyl eugenol. Host: The species is a major pest of edible and rainforest fruits (Allwood et al., 1999; CABI, 2017). The distribution has been suggested in previous surveys, however this is probably the first published record in Myanmar.

*Bactrocera (Bactrocera) correcta* (Bezzi) (Fig 1: 4)


*Bactrocera (Bactrocera) dorsalis* (Hendel) (Fig 1: 5, Fig 2)

Distribution: Asian countries such as Bhutan, Cambodia, Hong Kong, India, Laos, Myanmar, Nepal, Thailand, China, Sri Lanka, Taiwan and Vietnam (CABI, 2017; Drew and Romig, 2013). African countries including Angola, Benin and Congo. Oceania countries
<table>
<thead>
<tr>
<th>Species</th>
<th>Lure</th>
<th>Collection site</th>
<th>The report referring to distribution in Myanmar</th>
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</thead>
<tbody>
<tr>
<td><em>B. (Asiadacus) apicalis</em></td>
<td>Cue-lure</td>
<td>Hlegu (Y), Pegu (B) and Patheingyi (M)</td>
<td></td>
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<tr>
<td><em>B. (Bactrocera) bhutaniae</em></td>
<td>Cue-lure</td>
<td>Taunggyi (S) and Nyaung Shwe (S)</td>
<td></td>
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<tr>
<td><em>B. (Bactrocera) carambolae</em></td>
<td>Methyl eugenol</td>
<td>Hlegu (Y), Pegu (B), Sintgaing (M), Kalaw (S), Taunggyi (S) and Nyaung Shwe (S)</td>
<td>Drew and Romig (2013) / CABI (2017)</td>
</tr>
<tr>
<td><em>B. (Bactrocera) correcta</em></td>
<td>Methyl eugenol</td>
<td>Hlegu (Y), Pegu (B), Amarapura (M), Sintgaing (M), Patheingyi (M), Kalaw (S), Taunggyi (S) and Nyaung Shwe (S)</td>
<td>Drew and Romig (2013) / CABI (2017)</td>
</tr>
<tr>
<td><em>B. (Bactrocera) dorsalis</em></td>
<td>Methyl eugenol</td>
<td>Hlegu (Y), Pegu (B), Amarapura (M), Sintgaing (M), Patheingyi (M), Kalaw (S), Taunggyi (S) and Nyaung Shwe (S)</td>
<td>Drew and Romig (2013) / CABI (2017)</td>
</tr>
<tr>
<td><em>B. (Bactrocera) latifrons</em></td>
<td>Cue-lure</td>
<td>Insein (Y)</td>
<td>Carroll et al. (2002) / McQuate et al. (2013)</td>
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<tr>
<td><em>B. (Bactrocera) nigrifacia</em></td>
<td>Cue-lure</td>
<td>Pegu (B), Amarapura (M), Patheingyi (M) and Sintgaing (M)</td>
<td></td>
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<tr>
<td><em>B. (Bactrocera) rubigina</em></td>
<td>Cue-lure</td>
<td>Hlegu (Y), Pegu (B) and Sintgaing (M)</td>
<td></td>
</tr>
<tr>
<td><em>B. (Bactrocera) sp. near lateritaenia</em></td>
<td>Cue-lure</td>
<td>Hlegu (Y)</td>
<td></td>
</tr>
<tr>
<td><em>B. (Bactrocera) tuberculata</em></td>
<td>Methyl eugenol</td>
<td>Hlegu (Y), Pegu (B), Amarapura (M), Patheingyi (M), Sintgaing (M), Kalaw (S), Taunggyi (S) and Nyaung Shwe (S)</td>
<td>Drew and Romig (2013) / CABI (2017)</td>
</tr>
<tr>
<td><em>B. (Bactrocera) zonata</em></td>
<td>Methyl eugenol</td>
<td>Hlegu (Y), Pegu (B), Amarapura (M), Patheingyi (M), Sintgaing (M), Kalaw (S), Taunggyi (S) and Nyaung Shwe (S)</td>
<td>Drew and Romig (2013) / CABI (2017)</td>
</tr>
<tr>
<td><em>B. (Parasinodacus) cilifera</em></td>
<td>Cue-lure</td>
<td>Hlegu (Y), Pegu (B), Amarapura (M), Patheingyi (M), Sintgaing (M), Kalaw (S), Taunggyi (S) and Nyaung Shwe (S)</td>
<td>Drew and Romig (2013) / CABI (2017)</td>
</tr>
<tr>
<td><em>B. (Parasinodacus) incisa</em></td>
<td>Cue-lure</td>
<td>unknown (M)</td>
<td>Drew and Romig (2013)</td>
</tr>
<tr>
<td><em>B. (Sinodacuscus) hochii</em></td>
<td>Cue-lure</td>
<td>Hlegu (Y)</td>
<td></td>
</tr>
<tr>
<td><em>B. (Sinodacuscus) sp. laterum</em></td>
<td>Cue-lure</td>
<td>Pegu (B)</td>
<td></td>
</tr>
<tr>
<td><em>B. (Zeugodacuscus) caudata</em></td>
<td>Cue-lure</td>
<td>Hlegu (Y), Pegu (B), Amarapura (M), Patheingyi (M) and Sintgaing (M)</td>
<td>Drew and Romig (2013) / CABI (2017)</td>
</tr>
<tr>
<td><em>B. (Zeugodacuscus) cucurbitae</em></td>
<td>Cue-lure</td>
<td>Hlegu (Y), Pegu (B), Amarapura (M), Patheingyi (M), Sintgaing (M), Taunggyi (S) and Nyaung Shwe (S)</td>
<td>Drew and Romig (2013) / CABI (2017)</td>
</tr>
<tr>
<td><em>B. (Zeugodacuscus) diversa</em></td>
<td>Methyl eugenol</td>
<td>Hlegu (Y)</td>
<td></td>
</tr>
<tr>
<td><em>B. (Zeugodacuscus) isolata</em></td>
<td>Cue-lure</td>
<td>Amarapura (M) and Patheingyi (M)</td>
<td>Drew and Romig (2013) (mentioned as synonym of <em>B. zahadi</em>), CABI (2017)</td>
</tr>
<tr>
<td><em>B. (Zeugodacuscus) tau</em></td>
<td>Cue-lure</td>
<td>Hlegu (Y), Pegu (B), Amarapura (M), Patheingyi (M) and Sintgaing (M)</td>
<td></td>
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* Collection site indicates township and first letter of the production area: Yangon Region (Y), Bago Region (B), Mandalay Region (M) and Shan State (S).
Fig. 1. External morphological characteristics of twenty fruit fly species (1)
Fig. 1. External morphological characteristics of twenty fruit fly species (2)
Bactrocera (Hendel) (further).

that the classification and distribution area will be reorganized even
ling species in the latest research. In the future, there is a possibility

et al
nam and Taiwan (Doorenweerd
Bactrocera (Wang & Zhao)
rubigina
Bactrocera (Fig 1: 8)

bitaceae, Euphorbiaceae (Drew and Romig, 2013). This is probably

Such as French Polynesia, Palau and Papua New Guinea. Introduced
into Hawaii and Mariana Islands. Eradicaded from Ryukyu and Ogas-
Host: The species is a major pest of commercial edible fruits and wild
fruits (Allwood et al., 1999; CABI, 2017; Drew and Romig, 2013;
Tsuruta and White, 1997).

Scutum color pattern was highly variable, from almost entirely
black to entirely orange brown (Fig 2) in Myanmar. These color vari-
rations were found in populations in which B. dorsalis are recorded to
occur, i.e. Pakistan (Schutze et al., 2014), India (David and Ramani,
2011; Schutze et al., 2014) and Bangladesh (Leblanc et al., 2013).

Drew and Romig (2013) doubted the distribution of B. dorsalis in
India and Sri Lanka. In addition, Schutze et al. (2014) reorganized the
classification of a part species including B. dorsalis and several sib-
ling species in the latest research. In the future, there is a possibility
that the classification and distribution area will be reorganized even
further.

Bactrocera (Bactrocera) latifrons (Hendel) (Fig 1: 6)

Distribution: Asian countries including Indonesia, Thailand, Tai-
wan and Vietnam, and introduced into Hawaii (Carroll et al., 2002;
Drew and Romig, 2013). Attractant: No record. Host: Solanaceae and
nine other plant families (Allwood et al., 1999; CABI, 2017, Mc-
Quate and Liquido, 2013). The specimens have been bred from fresh
chili (Capsicum frutescens) in Yangon.

Bactrocera (Bactrocera) nigrifucia Zhang, Ji & Chen (Fig 1: 7)

Distribution: Bangladesh, China, Thailand and Taiwan (Lanyu Is.)
(Doorenweerd et al., 2019; Drew and Romig, 2013; Zhang et al.,
2011). Attractant: cue-lure. Host: Verbenaceae, Capparaceae, Cucur-
bitaceae, Euphorbiaceae (Drew and Romig, 2013). This is probably
the first record in Myanmar.

Bactrocera (Bactrocera) rubigina (Wang & Zhao) (Fig 1: 8)

Distribution: Bangladesh, Bhutan, China, Thailand, Northern Viet-
nam and Taiwan (Doorenweerd et al., 2019; Drew and Romig, 2013).

Attractant: cue-lure. Host: Litsea verticillata (Lauraceae)(Liang et al.,
1993). This is probably the first record in Myanmar.

Bactrocera (Bactrocera) sp. near lateritaenia Drew & Hancock (Fig 1: 9)

This specimen was similar in appearance to B. lateritaenia Drew
and Hancock which distributes in the Malay peninsula. Additional
specimens are required to reliably identify the species. B. lateritaenia
is reported from Brunei, Malaysia and Southern Vietnam (Drew and

Bactrocera (Bactrocera) tuberculata (Bezzi) (Fig 1: 10)

Distribution: Bhutan, China, Myanmar, Thailand and Vietnam
(Drew and Romig, 2013). Attractant: methyl eugenol. Host: Anacar-
diaceae, Caricaceae, Lecythidaceae, Myrtaceae, Polygalaceae, Rosa-
ceae, Sapotaceae (Allwood et al., 1999; CABI, 2017).

Bactrocera (Bactrocera) zonata (Saunders) (Fig 1: 11)

Distribution: Asian countries including Indonesia, Thailand and
Vietnam. Introduced into Mauritius and Egypt (CABI, 2017; Drew
and Romig, 2013). Attractant: methyl eugenol. Host: Wide range of
commercial edible fruits and wild fruits (Allwood et al., 1999; Drew
and Romig, 2013; Tsuruta et al., 1997).

Bactrocera (Parasinodacus) cilifera (Hendel) (Fig 1: 12)

Distribution: China, Indonesia, Laos, Malaysia, Taiwan, Thailand
and Vietnam (Drew and Romig, 2013). Attractant: cue-lure. Host:
Male flowers of Thladiantha hookeri (Cucurbitaceae)(Allwood et al.,
1999). Requires confirmation (Hancock and Drew, 2017). This is
probably the first record in Myanmar.

Bactrocera (Parasinodacus) incisa (Walker) (Fig 1: 13)

Distribution: China, India, Malaysia, Myanmar, Thailand and Viet-
nam (Drew and Romig, 2013; Hancock and Drew, 2017). Attractant:
cue-lure. Host: No record.

Bactrocera (Sinodacus) hochii (Zia) (Fig 1: 14)

Distribution: China, Bangladesh, Vietnam, Malaysia, Thailand and
Indonesia (Chua and Ooi, 1998; Drew and Romig, 2013; Hancock
and Drew, 2018). Attractant: cue-lure. Host: Gymnopetalum co-
chinchenis, Luffa aegyptiaca, Trichosanthes wawraei (Cucurbita-
ceae). This is probably the first record from the inland area of Myan-
mar.

Bactrocera (Sinodacus) sp. near laterum Wang (Fig 1: 15)

The specimens had the typical appearance of B. (Sinodacus) later-
um Wang in having distinct broad-sided lateral post-sutural yellow
vittae (Wang, 1996). Drew and Romig (2013) have organized B. lat-
erum as a new synonym of B. (Sinodacus) hochii. Additional speci-
mens are required to reliably identify the species. B. laterum is re-

**Bactrocera (Zeugodacus) caudata** (Fabricius) (Fig 1: 16)


**Bactrocera (Zeugodacus) cucurbitae** (Coquillett) (Fig 1: 17)

Distribution: The species is reported from many countries in the world. Introduced into many countries including Hawaii (USA), Papua New Guinea and Solomon Islands (Drew and Romig, 2013). Attractant: cue-lure. Host: The species is recorded from nineteen plant families including Cucurbitaceae, Fabaceae and Solanaceae (CABI, 2017).

**Bactrocera (Zeugodacus) diversa** (Coquillett) (Fig 1: 18)

Distribution: China, India, Pakistan, Nepal, Sri Lanka, Bangladesh, Thailand and Vietnam (Drew and Romig, 2013; Hancock and Drew, 2018). Attractant: methyl eugenol. Host: Flowers of Cucurbitaceae. *Hemigimnodacus* Hardy was placed as a new synonym of subgenus *Zeugodacus* Hendel, with B. (Z.) diversa (Coquillett) (Hancock and Drew, 2018). This is probably the first record in Myanmar.

**Bactrocera (Zeugodacus) isolata** (Hardy) (Fig 1: 19)


**Bactrocera (Zeugodacus) tau** (Walker) (Fig 1: 20)

Distribution: Bangladesh, Bhutan, Brunei, China, India, Sri Lanka, Cambodia, Laos, Malaysia, Myanmar, Singapore, Thailand, Vietnam, Taiwan and Indonesia (CABI, 2017; Drew and Romig, 2013). Attractant: cue-lure. Host: The species is recorded from nineteen plant families including Cucurbitaceae and Fabaceae (CABI, 2017). Although sibling species *B. zahadi* is reported from Myanmar (Mahmood, 1999), Drew and Romig (2013) suggests that both species might be synonyms. While further investigation of both species is necessary, we identified the specimens as *B. tau* according to Drew and Romig (2013) in this report.

**Acknowledgements**

We would like to thank Ms. Tar Nway Oo (PPD Yangon), Ms. Thee Su Su Aung (PPD Yangon), Ms. Tinzar Hla Oo (PPD Yangon), Mr. Zayar Soe (PPD Yangon) and other members of the PPD regional office for all their assistance on site. Colleagues of the Naha Plant Protection Office supplied many materials for provision of the trapping work. Colleagues of the NPPS helped to discriminate the fruit flies. We are grateful to Mr. Y. Yokoi (YPPS), Mr. M. Kaneda (YPPS) and Mr. H. Matsuura (Kobe Plant Protection Station), who reviewed drafts and provided critical comments. This activity was supported by the JICA, Rural Development Department and the JICA Myanmar Office. Also, we gratefully thank the Government of Myanmar, particularly the Plant Protection Division (PPD) of the Ministry of Agriculture, Livestock and Irrigation (MOALI) and the Plant Protection Division of Ministry of Agriculture, Forestry and Fisheries (MAFF) of Japan for various arrangements necessary for the research work.

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和文摘要

ミャンマーのマンゴウ栽培園地におけるミバエの記録

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2014年1-2月及び同年5-6月の2回、JICAによる「ミャンマー植物防疫技術協力に係るミバエ調査」の一環として、ミャンマーの主要なマンゴウ生産地域であるヤンゴン、バゴー、マンデー、そしてシャン州南部のマンゴウ生産園地において、マンゴウ生果実の害虫であるミバエを特定するための野外調査を実施した。マンゴウ生果実を中心とした寄主植物採集とメチルユーチノールとキュウリュールを用いたトラップにより、ヤンゴン、バゴー、マンデー、シャン州南部の主要なマンゴウ生産地で7万頭を超えるミバエを採集して識別・同定した結果、Bactrocera. correcta, B. cucurbitae, B. dorsalis等の主要な害虫種を含む合計20種のミバエが確認された。これらのうち9種は、おそらくミャンマーからは初めての報告となる。マンゴウ生産園地及びその周辺の限られた調査範囲にもかかわらず20種ものミバエが確認され、ミャンマーにおけるミバエ種の多様性が示された。

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