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Hirashima, Yoshihiro

Abe, Masaki

Tadauchi, Osamu

Konishi, Kazuhiko

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THE HYMENOPTEROUS PARASITIDS
OF THE DIAMONDBACK MOTH, *PLUTELLA XYLOSTELLA*
(LEPIDOPTERA, YPONOMEUTIDAE) IN JAPAN*

YOSHIHIRO HIRASHIMA, MASAKI ABE, OSAMU TADAUCHI

Entomological Laboratory, Faculty of Agriculture,
Kyushu University, Fukuoka 812, Japan

KAZUHIKO KONISHI

Laboratory of Insect Systematics, National Institute of
Agro-Environmental Sciences, Tsukuba 305, Japan

and

KAORU MAETO

Entomological Laboratory, Forestry and Forest Research
Institute, Sapporo 004, Japan

Abstract

Hymenopterous parasitoids of the diamondback moth occurring in Japan are summarized as follows (species with an asterisk indicates secondary parasitoid and a dagger shows the primary and secondary parasitoid) :

Braconidae

Apanteles plutellae Kurdjumov

Ichneumonidae

Diadegma sp. 1

Diadegma sp. 2

Diadromus subtilicornis (Gravenhorst)

Coccygominus nipponicus (Uchida)

† *Itoplectis alternans spectabilis* (Matsumura)

† *Itoplectis narangae* (Ashmead)

* *Gelis* sp.

Trichogrammatidae

Trichogramma chilonis Ishii

Eulophidae

* Contribution from the Entomological Laboratory, Faculty of Agriculture, Kyushu University, Fukuoka (Ser. 3, No. 292).

- Tetrastichus sokolowskii* Kurdjumov
Chalcididae
Brachymeria excarinata Gahan
Pteromalidae
* *Trichomalopsis oryzae* Kamijo et Grissell
* *Dibrachys* sp.

Introduction

The diamondback moth, *Plutella xylostella* (Linnaeus) is a serious pest of cruciferous vegetables throughout the world.

In Japan, the diamondback moth was a minor pest before 1965 (Koshihara, 1986), but recently it has become one of the most serious pests of cruciferous vegetables such as cabbages, radishes and turnips. This is partly because of the development of resistance to pesticides in this species owing to frequent use of them.

Biological control of the diamondback moth may be effective if we can find any good control agents. In order to know useful parasites and predators of the diamondback moth in Japan, we have conducted field surveys from 1986 incorporated with Prof. T. Miura of Shimane University and Prof. K. Nohara of Kyushu Tokai University.

This paper reports the occurrence of the hymenopterous parasitoids of the diamondback moth in Japan as a part of the result of our investigation.

Materials and Methods

From the spring of 1986 to the autumn of 1987, eggs, larvae and pupae of the diamondback moth were collected in the field at the following localities in Japan.

Gunma Pref. : Tsumagoi-mura, Azuma-gun, 27. vii. 1986 (O. Tadauchi & K. Yamagishi).

Yamanashi Pref. : Ooizumi, Kitakoma-gun, 31. vii. 1986 ; Nagasaka, Kitakoma-gun, 31. vii. 1986 ; Kobuchizawa, Kitakoma-gun, 31. vii. 1986 (O. Tadauchi & K. Yamagishi).

Nagano Pref. : Wada, Chiisagata-gun, 26. vii. 1986 ; Tateshina, Kitasaku-gun, 26. vii. 1986 ; Tobu, Chiisagata-gun, 26-27. vii. 1986 ; Karuizawa, Kitasaku-gun, 27. vii. 1986 ; Miyota, Kitasaku-gun, 27. vii. 1986 ; Komoro, 27. vii. 1986 ; Nagano, 28. vii. 1986 ; Sakai, Higashichikuma-gun, 28. vii. 1986 ; Susaka, 28. vii. 1986 ; Aoki, Chiisagata-gun, 28. vii. 1986 ; Ooka, Sarashina-gun, 28. vii. 1986 ; Yachiho, Minamisaku-gun, 29. vii. 1986 ; Usuda, Minamisaku-gun, 29. vii. 1986 ; Fujimi, Suwa-gun, 30. vii. 1986 ; Koumi, Minamisaku-gun, 30. vii. 1986 ; Chino, 30. vii. 1986 (O. Tadauchi & K. Yamagishi).

Tottori Pref. : Hyonosen, Yazu-gun, 7. x. 1987 (Y. Hirashima & M. Abe).

Shimane Pref. : Nishiinbe, Matsue, 25. vii. 1986 (T. Miura).

Fukuoka Pref. : Shimobaru, Fukuoka, 31. iii. 1986 (N. Koda, K. Konishi & M. Abe) ; 13. iv. 1986 (M. Abe) ; 16. iv. 1986 (S. Naomi, K. Konishi & M. Abe) ; 15. v. 1986 ; 20. v. 1986 (M. Abe & M. Y. Oshida).

Oita Pref. : Yoshibu, Kusu-gun, 21. v. 1986 (Y. Abe) ; 31. viii. 1986 (O. Tadauchi & M. Abe) ; 3. ix. 1987 (M. Abe & O. Imoto).

Kumamoto Pref. : Kugino, Aso-gun, 14. iv. 1987 (O. Tadauchi & M. Abe) ; 6-7. v. 1987 ; 10-11. vi. 1987 ; 24-25. vi. 1987 ; 8-9. vii. 1987 ; 22-23. vii. 1987 ; 19-20. viii. 1987 ; 2-3. ix. 1987 ; 16-17. ix. 1987 ; 30. ix. 1987 ; 1. x. 1987 (M. Abe, O. Imoto & T. Higaki) ; 28-30. v. 1987 (M. Abe & K. Yahiro). Choyo,

Aso-gun, 21. v. 1986 ; 27. v. 1986 ; 10. vi. 1986 ; 17. vi. 1986 ; 26. vi. 1986 (K. Ishikawa). Takamori, Aso-gun, 8-9. vii. 1987 ; 16-17. ix. 1987 (M. Abe, O. Imoto & T. Higaki). Ichinomiya, Aso-gun, 20. viii. 1987 (M. Abe, O. Imoto & T. Higaki). Ozu, Kikuchi-gun, 21. v. 1986 (K. Ishikawa) ; 8-9. vii, 1987 ; 1. x. 1987 (M. Abe, O. Imoto & T. Higaki).

Miyazaki Pref. : Miyazaki, 28. ii. 1986 ; 7. iv. 1986 ; 19. v. 1986 ; 22. v. 1966 ; 6. vi. 1986 ; 9. vi. 1986 ; 1. x. 1986 ; 6. x. 1986 ; 17. x. 1986 ; 19. x. 1986 ; 11. xi. 1986 ; 13. xi. 1986 (T. Yamashita).

Kagoshima Pref. : Okuchi, 13. iv. 1986 (Y. Hirashima). Mizobe, Aira-gun, 26-28. iv. 1986 (Y. Hirashima & M. Abe) ; 3-4. iv. 1986 (O. Tadauchi & M. Abe).

Okinawa Pref. : Sashiki, Okinawa Is., 17. iv. 1986 ; Motobu, Okinawa Is., 24. iv. 1986 (S. Nomura, M. Yoshida & T. Yasunaga).

The samples brought in the laboratory were placed in rearing cages kept under room temperature. If necessary, fresh host plant material was supplied. These samples were checked daily for emergence of the parasitoids.

Results

Ten species of hymenopterous parasitoids attacking the diamondback moth were obtained as listed below. Seven of them are primary parasitoids, one is a primary and secondary parasitoid, and two are secondary ones.

BRACONIDAE

1. *Apanteles plutellae* Kurdjumov

[Japanese name : Konaga-samurai-komayu-bachi]

(Fig. 1)

Watanabe, 1963, Ins. Matsum., 26 : 63 ; Yasumatsu & Watanabe, 1964, A Tentative Catalogue of Insect Natural Enemies of Injurious Insects in Japan, 1, pp. 166 ; Matsuura, 1977, Bull. Fac. Agr. Mie Univ., 54 : 46-48 ; Yamada & Yamaguchi, 1985, Jpn. J. Appl. Ent. Zool., 29 : 170-173 ; Iga, 1985, Jpn. J. Appl. Ent. Zool., 29 : 119-125 ; Kitauchi & Nogami, 1985, Proc. Assoc. Plant Prot., Kyushu, Fukuoka, 30 : 124-125 ; present study.

MATERIAL EXAMINED : 325 ♀♀ 280 ♂♂ from the following localities : Gunma Pref. : Tsumagoi, Azuma-gun, Yamanashi Pref. : Kitakoma-gun. (Nagasaka, Kobuchizawa, Ooizumi). Nagano Pref. : Chiisagata-gun (Aoki, Tobu, Wada) ; Kitasaku-gun (Karuizawa) ; Komoro ; Nagano ; Sarashina-gun (Ooka) ; Minamisaku-gun (Koumi, Usuda, Yachiho) ; Suwa-gun (Fujimi) ; Higashichisagata-gun (Sakai) ; Susaka ; Chino. Tottori Pref. : Yazu-gun (Hyonosen). Fukuoka Pref. : Fukuoka (Shimobaru). Oita Pref. : Kusu-gun (Yoshihbu). Kumamoto Pref. : Aso-gun (Choyo, Kugino, Takamori, Ichinomiya) ; Kikuchi-gun (Ozu). Miyazaki Pref. : Miyazaki. Kagoshima Pref. : Aira-gun (Mizobe) ; Okuchi. Okinawa Pref. : Okinawa Is. (Sashiki, Motobu).

BIOLOGICAL NOTES : Solitary endophagous primary parasitoid of larvae ; multivoltine with high percentage parasitism from late spring to early summer (Matsuura, 1977 ; Yamada & Yamaguchi, 1985 ; present study).

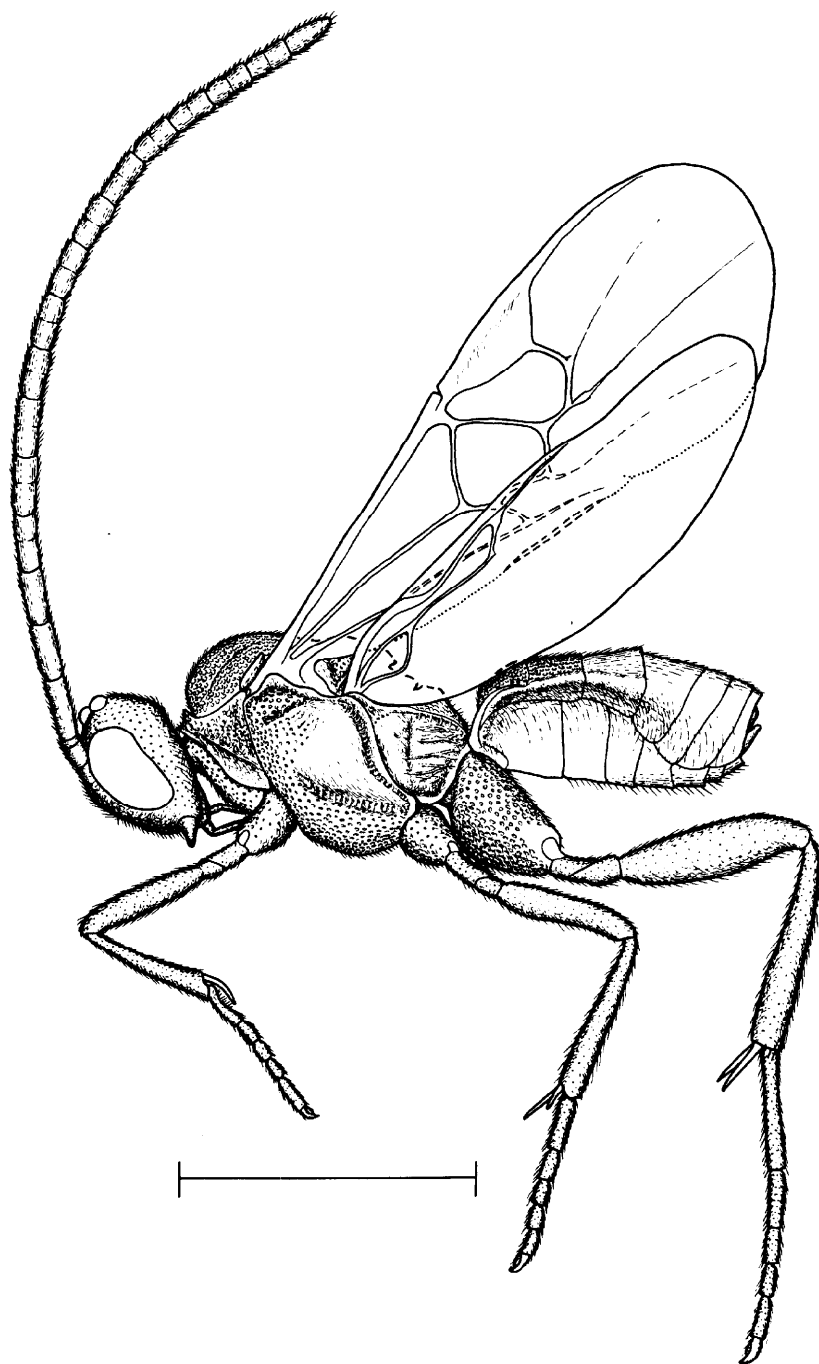


Fig. 1. *Apanteles plutellae* Kurdjumov, ♀. Habitus in lateral view. Scale: 1.0 mm.

ICHNEUMONIDAE

2. *Diadegma* sp. 1

(Fig. 2)

MATERIAL EXAMINED : Kumamoto Pref. : 2 ♂♂, Ozu, Kikuchi-gun, 21. v. 1986 (K. Ishikawa) ; 1 ♀, Choyo, Aso-gun, 27. v. 1986 (K. Ishikawa) ; 1 ♀, same locality and collector, 10. vi. 1986 Kugino, Aso-gun, 6. v. 1987 (M. Abe).

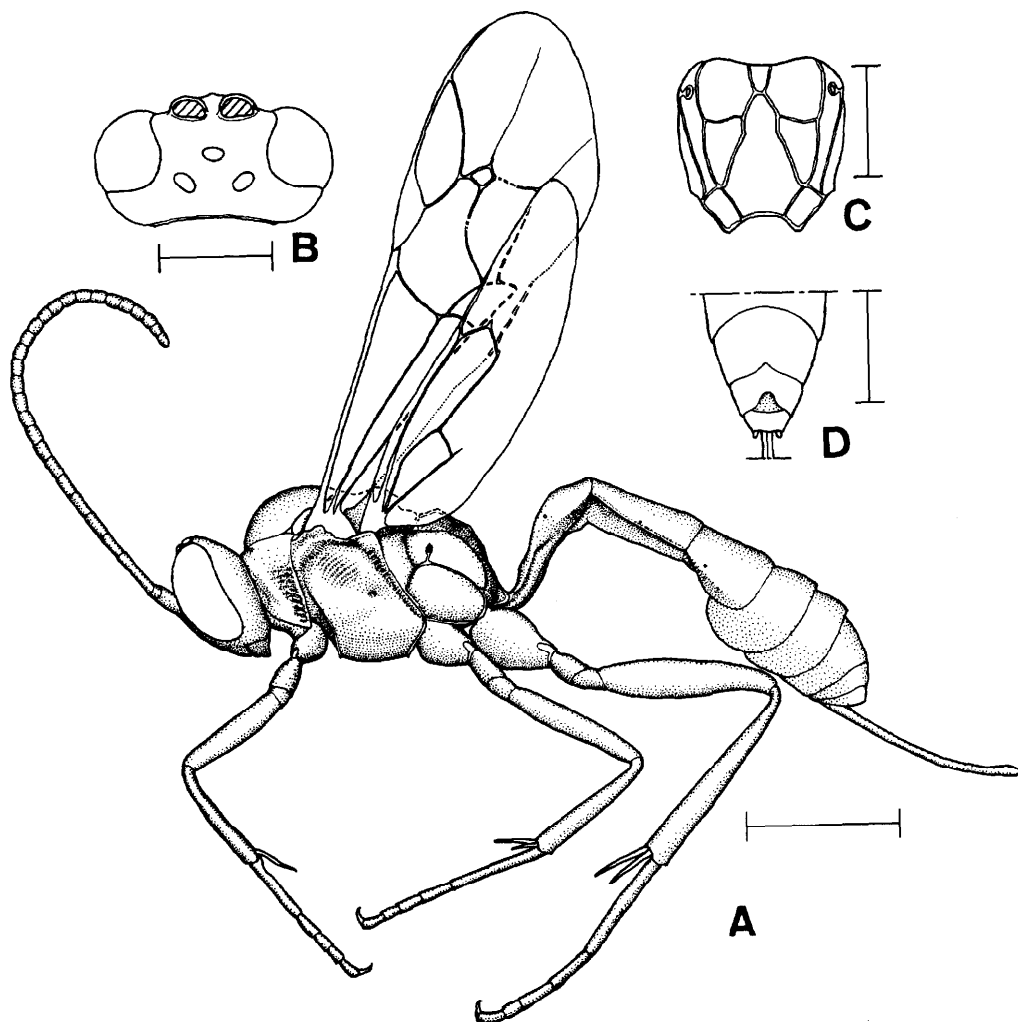


Fig. 2. *Diadegma* sp. 1, ♀. A, habitus in lateral view ; B, head in dorsal view ; C, propodeum in dorsal view ; D, apex of abdomen in dorsal view. Scales : A, 1.0 mm ; B-D, 0.5 mm.

BIOLOGICAL NOTES : Solitary endophagous primary parasitoid of larvae.

REMARKS : Matsuura (1977) and Yamada & Yamaguchi (1985) recorded *Diadegma* sp., but we found two *Diadegma*-species parasitizing the diamondback moth in this study. We do not know which one is the species previously recorded.

3. *Diadegma* sp. 2

MATERIAL EXAMINED : Kumamoto Pref. : 1♀, Ozu, Kikuchi-gun, 13. v. 1986 (K. Ishikawa) ; 1♀, same locality and collector, 4. vi. 1986 ; 2♀♀, Kugino, Aso-gun, 10. vi. 1987 (M. Abe).

BIOLOGICAL NOTES : Solitary endophagous primary parasitoid of larvae.

REMARKS : This species is easily distinguished from the preceding species by the absence of the 2nd intercubitus and the short ovipositor which is as long as the apical depth of abdomen.

4. *Diadromus subtilicornis* (Gravenhorst)

(Fig. 3)

Matsuura, 1977, Bull. Fac. Agr. Mie Univ., 54 : 46-47 ; Kitayama & Nogami, 1984, Proc. Assoc. Plant. Prot. Kyushu, Fukuoka, 30 : 124-125 ; Yamada & Yamaguchi, 1985, Jpn. J. Appl. Ent. Zool., 29 : 172 ; present study.

MATERIAL EXAMINED : Yamanashi Pref. : 1♀, Kobuchizawa, Kitakoma-gun, 31. vii. 1986 (O. Tadauchi & K. Yamagishi). Nagano Pref. : 8♀♀9♂♂, Tateshina, Kitasaku-gun, 26. vii. 1986 ; Tobu, 19♀♀226♂♂, Chiisagata-gun, 26-27. vii. 1986 ; 7♀♀2♂♂, Komoro, 27. vii. 1986 ; 1♀1♂, Matsushiro, 28. vii. 1986 ; 2♂♂, Nagasaka, Kitakoma-gun, 31. vii. 1986 ; 1♂, Wada, Chiisagata-gun, 26. vii. 1986 ; Fujimi, Suwa-gun, 30. vii. 1986 ; Yachiho, Minamisaku-gun, 29. vii. 1986 ; 1♀, Nagano, 28. vii. 1986 (O. Tadauchi & K. Yamagishi). Kumamoto Pref. : 2♀♀3♂♂, Choyo, Aso-gun, 10. vi. 1986 (K. Ishikawa) ; 1♂, same locality and collector, 21. v. 1986 ; 1♂, same locality and collector, 17. vi. 1986 ; 10♀♀90♂♂, Kugino, Aso-gun, 10. vi. 1987 (M. Abe) ; 10♀♀16♂♂, same locality and collector, 24. vi. 1987.

BIOLOGICAL NOTES : Solitary endophagous primary parasitoid of prepupae and pupae ; multivoltine (Matsuura, 1977 ; Yamada & Yamaguchi, 1985). According to our investigation, the percentage parasitism of this species was high from late May to June in Aso-nango-dani, Kumamoto Prefecture.

5. *Coccygominus nipponicus* (Uchida)

Yamada & Yamaguchi, 1985, Jpn. J. Appl. Ent. Zool., 29 : 172 ; present study.

MATERIAL EXAMINED : Kumamoto Pref. : 1♂, Choyo, Aso-gun, 10. vi. 1986 (K. Ishikawa).

BIOLOGICAL NOTES : Solitary endophagous primary parasitoid of larvae (Yamada & Yamaguchi, 1985). Nine lepidopterous and one hymenopterous hosts were recorded (Uchida, 1928, 1933, 1955 ; Kato et al., 1951 ; Iwata, 1961 ; Minamikawa, 1969 ; Kusigemati, 1976).

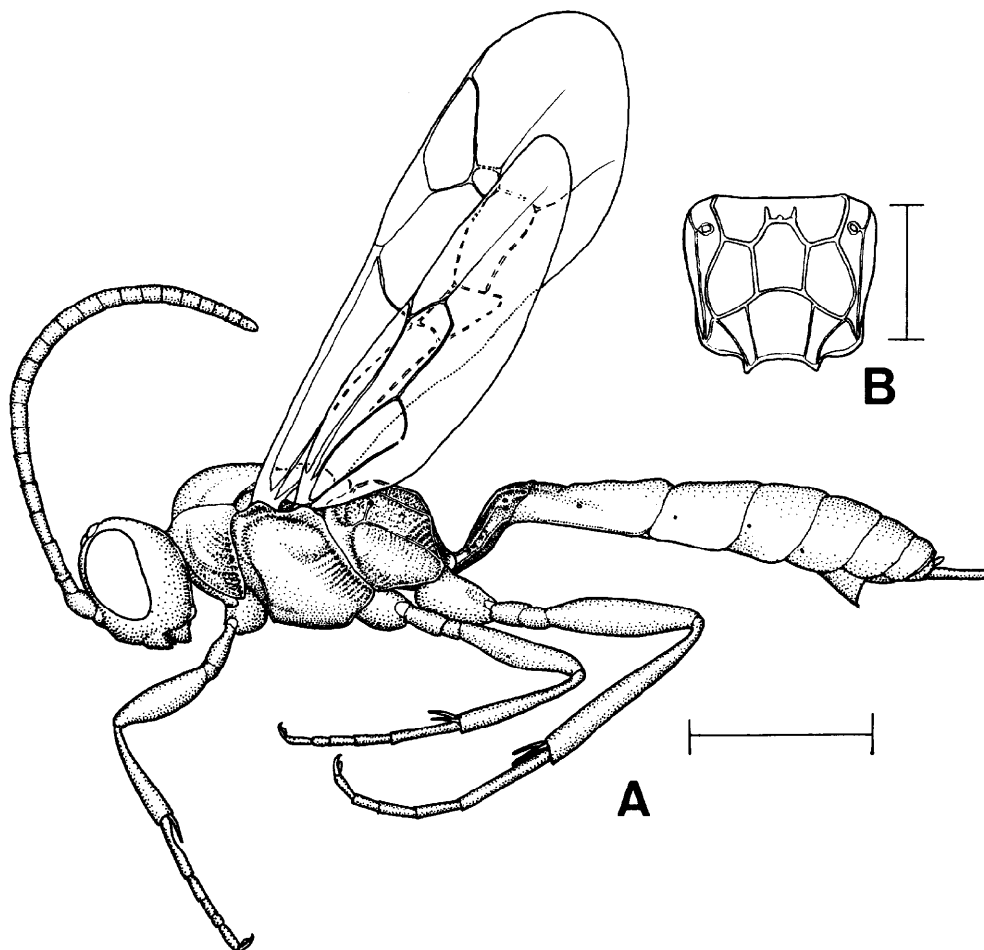


Fig. 3. *Diadromus subtilicornis* (Gravenhorst), ♀. A, Habitus in lateral view ; B, propodeum in dorsal view. Scales : A, 1.0 mm ; B, 0.5 mm.

6. *Itopectis alternans spectabilis* (Matsumura)

[Japanese name : Matsu-kemushi-hirata-himebachi]

Minamikawa, 1969, Kontyû, Tokyo, 37 (2) : 220-232 ; Matsuura, 1977, Bull. Fac. Agr. Mie Univ., 54 : 46 ; present study.

MATERIAL EXAMINED : Kumamoto Pref. : 1♂, Choyo, Aso-gun, 26. vi. 1986 (K. Ishikawa).

BIOLOGICAL NOTES : Solitary endophagous primary and secondary parasitoid of pupae. The host range is very wide; 34 species of Lepidoptera, 2 species of Coleoptera (Curculionidae and Chrysomelidae) and 4 species of Hymenoptera (Ichneumonidae and Braconidae) were recorded as the

hosts (Takagi, 1925 ; Matsumura, 1926 ; Uchida, 1928, 1933, 1937 ; Kamiya, 1936, 1939, 1941 ; Haussler, 1940 ; Iwata, 1961 ; Kobayashi, 1962 ; Momoi & Kamijo, 1963 ; Momoi, 1966, 1973 ; Minamikawa, 1969 ; Togashi, 1974 ; Momoi, Sugawara & Honma, 1975 ; Kusigemati, 1976, 1986, 1987, Matsuura, 1977).

7. *Gelis* sp. (new record)

MATERIAL EXAMINED : Kumamoto Pref. : 1♀, Choyo, Aso-gun, 14. vi. 1986 (K. Ishikawa) Shimane Pref. : 19, Nishiinbe, Matsue, 25. vii. 1986 (T. Miura) ; Nagano Pref. : 2♂♂, Tobu, Chiisagata-gun, 26. vii. 1986 (O. Tadauchi & K. Yamagishi).

BIOLOGICAL NOTES : Solitary endophagous secondary parasitoid emerging from the pupa of *Apanteles plutellae*.

TRICHOGRAMMATIDAE

8. *Trichogramma chilonis* Ishii [Japanese name : Meaka-tamagobachi]

Iga, 1985, Jpn. J. Appl. Ent. Zool., 29 : 124 ; present study.

MATERIAL EXAMINED : Shimane Pref. : 1♀ 36, Izumo, 9. vii. 1986 (T. Miura).

BIOLOGICAL NOTES : Solitary endophagous primary parasitoid of eggs ; multivoltine with high percentage parasitism from late May to the summer (Iga, 1985).

EULOPHIDAE

9. *Tetrastichus sokolowskii* Kurdjumov

Kitauchi & Nogami, 1984, Proc. Assoc. Plant Prot. Kyushu, Fukuoka, 30: 124-125 ; Yamada & Yamaguchi, 1985, Jpn. J. Appl. Ent. Zool., 29 : 170-173 ; present study.

MATERIAL EXAMINED : 320♀♀ 5606♂ from the following localities : Nagano Pref. : Chiisagata-gun (Tobu) ; Komoro ; Nagano ; Minamisaku-gun (Usuda) ; Suwa-gun (Fujimi) ; Kitakoma-gun (Ooizumi) ; Chino. Tottori Pref. : Yazu-gun (Hyonosen). Kumamoto Pref. : Aso-gun (Choyo, Ichinomiya, Kugino, Takamori) ; Kikuchi-gun (Ozu). Miyazaki Pref. : Miyazaki.

BIOLOGICAL NOTES : Gregarious endophagous primary parasitoid of larvae-pupae ; multivoltine with high percentage parasitism from early summer to early autumn (Yamada & Yamaguchi, 1985). We also confirmed the statement of Yamada & Yamaguchi, 1985.

PTEROMALIDAE

10. *Trichomalopsis oryzae* Kamijo et Grissel (new record)

MATERIAL EXAMINED : Kumamoto Pref. : 1♀, Kugino, Aso-gun, 10. vi. 1987 (M. Abe).

BIOLOGICAL NOTES : Solitary endophagous secondary parasitoid attacking *Apanteles plutellae*.

According to Kamijo & Grissell (1982), this species was known as the primary parasite of *Oulema oryzae* (Kuwayama), *Bucclatrix pyrivorella* Kuroko, *Agromyza oryzae* Munakata, *Hydrellia griseola* Fall&n and *Allognosta sapporensis* Matsumura and also as the secondary parasite of the pupa of *Apanteles ruficrus* Haliday which parasitizes *Naranga aenescens* Moore, *A. glomeratus* (L.) and *Microplitis medianus* Ruthe.

The following three species were previously recorded from Japan as species associated with the diamondback moth, but are not obtained by our present investigation.

ICHNEUMONIDAE

1. *Itopectis narangae* (Ashmead)

[Japanese name : Aomushi-hirata-himebachi]

Minamikawa, 1969, Kontyû, Tokyo, 37 (2) : 220-232 ; Matsuura, 1977, Bull. Fac. Agr. Mie Univ., 54 : 47 ; Kusigemati, 1987, Akitu, N. Ser. No. 88 : 2.

BIOLOGICAL NOTES : Solitary endophagous primary and secondary parasitoid of pupae. This species is known as the parasitoid of 11 species of Lepidoptera and 2 species of Coleoptera (Ashmead, 1906 ; Nawa, 1928 ; Uchida, 1923 ; Matsumura, 1931 ; Kuwayama, 1932 ; Sasaki, Ikeda & Sameshima, 1941 ; Kamiya, 1941 ; Minamikawa, 1954, 1969 ; Momoi, 1961, 1966, 1973 ; Kushigemati, 1972, 1976, 1987 ; Togashi, 1974).

CHALICIDIDAE

2. *Brachymeria excarinata* Gahan

Matsuura, 1977, Bull. Fac. Agr. Mie Univ., 54 : 47.

BIOLOGICAL NOTES : Solitary endophagous primary parasitoid of pupae (Matsuura, 1977).

PTEROMALIDAE

3. *Dibrachys* sp.

Yamada & Yamaguchi, 1985, Jpn. J. Appl. Ent. Zool., 29 : 172.

BIOLOGICAL NOTES : Secondary parasitoid emerging from the parasitized prepupa of the diamond-back moth (Yamada & Yamaguchi, 1985).

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