

**A new host record of *Ephialtes hokkaidonis* Uchida (Hymenoptera:  
Ichneumonidae: Pimplinae) with a description of oviposition behavior**

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**エゾフシオナガヒメバチ (膜翅目：ヒメバチ科) の新寄主記録と産卵行動**

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**抄録：**エゾフシオナガヒメバチ *Ephialtes hokkaidonis* の寄主として、甲虫の脱出孔に営巣するハムシドロバチを新たに記録した。野外観察により、本種の産卵行動は1) ホストの巣の発見、2) 産卵管の定位、3) 穿孔・産卵の3つの段階から構成されること、寄主巣の穿孔に際して、産卵管は泥壁に強く突き立てられることなく、微小な突起列を備えた産卵管下弁の動きによって、徐々に寄主巣に差し込まれていくことが明らかになった。産卵管の詳細な観察では、産卵管は上下にやや扁平で、先端付近ではその下弁が上弁をおおう構造となっていた。これまでに記録された本種や本種の含まれる *Ephialtes* 属の寄主は、材穿孔者と借孔性の有剣類に分けられるが、産卵行動と産卵管の構造から考えて、通常の寄主は有剣類であると考えられた。これまで未知であった本種の幼生期とオス成虫についても記載を行った。

**Abstract:** *Ephialtes hokkaidonis* was found to be a parasitoid of a mud wasp, *Symmorphus* sp. (Hymenoptera, Vespidae). Examination of *Symmorphus* nest that was infested by *E. hokkaidonis* revealed that the females lay an egg by penetrating the mud end plug of host nest and its larva grew up as an external idiobiont. Observed oviposition behavior of the parasitoid consisted of three stages, 1) detecting the host nest, 2) ovipositor locating, and 3) penetrating and laying eggs. When penetrating the end plug, ovipositor tip seemed not so strongly pressed against the plug, but a tiny hole was made and it was spread by the back and forth movement of small teeth of lower valves of ovipositor. *E. hokkaidonis* is unique in the structure of ovipositor tip, as it is cylindrical and somewhat depressed, with its lower valve forming the large dorsal lobe which is equipped with close teeth and almost encloses upper valve from the tip to the basal tooth. Recorded hosts of the genus *Ephialtes* were reviewed and divided into two groups, woodborers and tube nesting Aculeate. Based on the oviposition behavior and the structure of ovipositor, the regular host of *Ephialtes hokkaidonis* and presumably its congeners seemed to be an Aculeate Hymenoptera. Immature stages and unknown male of this species were also described.

**Key Words:** *Ephialtes hokkaidonis*; host; parasitism; *Symmorphus*; Vespidae; oviposition behavior; male

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*Ephialtes* Gravenhorst, 1829 is a Holarctic ichneumonid genus consisting of 16 species (including 5 species whose taxonomic positions are uncertain) (Yu & Horstmann, 1999). Up to the present, a single species, *Ephialtes hokkaidonis* Uchida, 1928 was known from Japan (Uchida, 1928, 1930; Matsumura, 1931; Iwata, 1958, 1960), but its male has been unknown. A rather wide range of insects, including wood boring Coleoptera, Lepidoptera, and Aculeate Hymenoptera, was recorded as the host of the genus. Referring recorded biology of Nearctic *E. spatulatus* (Townes, 1960), Townes pointed out "It has been an easy step for someone rearing both the parasite and coleopterous borer from a piece of wood to conclude that the borer was the host. More careful work, however, has shown that this and related species are parasites in the cell of bees and wasps nesting in wood." Therefore in the case of recording a host of a parasitoid that emerged from dead wood like *Ephialtes*, remains of a host and a parasitoid should be examined carefully to detect a precise host. A precise host record can be of great value in the analysis of phylogeny and evolution of host utilization. Uchida (1930) recorded *Pissodes cembrae* Motschulsky, and *Pissodes nitidus* Roelofs (Coleoptera, Curculionidae) as hosts of *E. hokkaidonis*, without any comments of detailed examination stated above.

Recently I observed that females of *E. hokkaidonis* inserted their ovipositors into nests of a mud wasp, *Symmorphus* sp. (Hymenoptera, Vespidae) on logs of Japanese cedar *Cryptomeria japonica*. In this study the oviposition behavior of this species was described and figured. The host, mode of parasitism, immature stages, and unknown male of *E. hokkaidonis* were described based on the detailed examination of host nest and on reared materials. The host range of the genus is also discussed referring to the structure of ovipositor tip and oviposition behavior.

### Materials and Methods

Oviposition behavior of females of *E. hokkaidonis* was observed on 4th June in 2003 at Himitani (35°7'44"N, 134°34'1"E. (WGS 84). 190m alt.), in Haga Town, Hyogo Prefecture, Honshu. The logs of Japanese cedar containing *Symmorphus* sp. nests, into which females inserted their ovipositors, were taken to the laboratory for rearing and detailed examination. After the logs were splitted by a hatchet to expose the nests, the contents of host nests were examined. The external morphological structures were observed under a stereoscopic microscope. A scanning electron microscope was used for detailed observation of the ovipositor.

The method of preparation of larval exuviae follows Wahl (1984), but after ultrasonification they were washed in distilled water directly and examined. Male genitalia were prepared by the method of Konishi (1985). Terminology of larval cephalic structures and adult morphology follows Finlayson (1975) and Short (1978), and Fitton et al. (1988), respectively. All materials used in this study are deposited in the collection of the Osaka Museum of Natural History (OMNH).

### Results

**Host and mode of parasitism.** *Symmorphus* sp. nesting in an emergence gallery of coleopterans, possibly cerambycids, on logs of Japanese cedar was found to be a host of *E.*

*hokkaidonis*. Its females were strongly attracted to the *Symmorphus* nests. In case of that the attracted females were disturbed and flew away from the host nests, they soon returned to host nests. In one case three females were observed to penetrate mud end plugs of different host nests on one log.

The nest of *Symmorphus* sp. twelve days after attacked by *E. hokkaidonis* female is shown in Fig. 1. The contents of host nest are shown in Table 1. The pupa, head capsules of younger instars of parasitoid and consumed host larva were scattered in the cell III. In the cell IV a healthy host larva was found. This larva seemed to escape from the attack of parasitoid because the distance between the cell and end plug was longer than the

ovipositor length. Determination of remains of host and parasitoid in the cell revealed that the larva of *E. hokkaidonis* is an external parasitoid as other members of Ephialtini. As each cell of host nest is separated from the neighboring cells by mud walls, the parasitoid larva mature on a single host larva. As multiple eggs were found in the cells II and I, the females could not recognize whether the nest had been already attacked or not strictly.

**Oviposition behavior.** Oviposition behavior of *E. hokkaidonis* consisted of three stages, 1) detecting the host nest, 2) ovipositor locating, and 3) penetrating mud plugs and walls and laying eggs. In first stage a female that reached the log containing host nest, began antennation (Fig. 2A) searching for host nest. When the female found out an end plug of the host, the antennation became more intensive. She continued antennation facing to and moving around the end plug. In the following second stage, the female began to raise her abdomen and stepped over the plug and moved forward slowly (Fig. 2B). During this phase she stopped the antennation and stretched antennae out forward and her ovipositor became completely exposed from its sheath. The female raised her abdomen above the head gradually and moved straight forward for about her body length excluding ovipositor. In this process the ovipositor tip was kept touching the surface of log. The ovipositor tip came to closer to the plug. As the female moved forward, and finally it was located on the plug (Fig. 2C). In the third stage the female drilled through the end plug with her ovipositor. In this process the ovipositor was not thrust on the plug so strongly, but each tip of lower ovipositor valves were observed to move back and forth very quickly and the ovipositor inserted into the host nest slowly. The female stopped her motion sometimes, at that time she seemed to penetrate cell

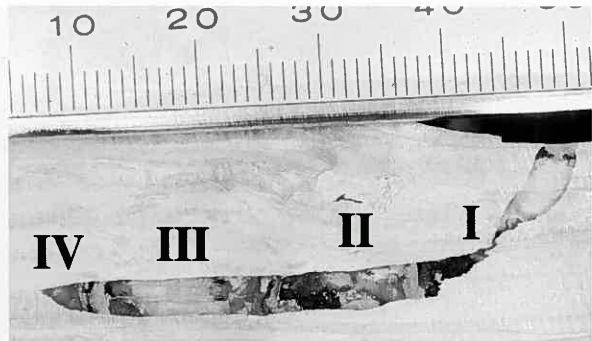
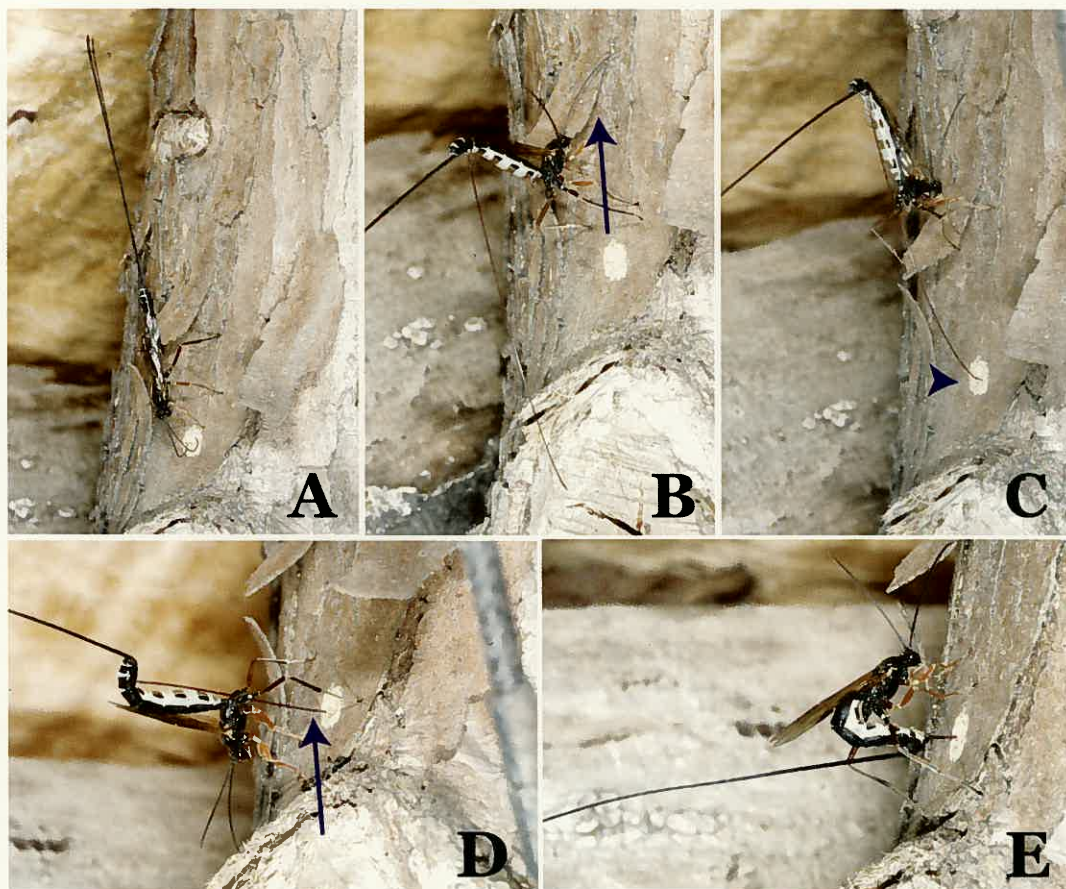


Fig. 1. A nest of *Symmorphus* sp. infested by *E. hokkaidonis*.

Table 1. Contents of the host nest infested by *E. hokkaidonis*.

Cell No.	Cell contents	Status
I	2 eggs of <i>E. hokkaidonis</i>	dead
	2 larvae of <i>E. hokkaidonis</i>	dead
	1 larva of <i>Symmorphus</i> sp.	dead
II	3 eggs of <i>E. hokkaidonis</i>	dead
	2 larvae of <i>E. hokkaidonis</i>	dead
	1 larva of <i>Symmorphus</i> sp.	dead
III	1 pupa of <i>E. hokkaidonis</i> healthy	healthy
	1 larva of <i>Symmorphus</i> sp.	dead
IV	prepupa of <i>Symmorphus</i> sp.	healthy*

\*failed to pupate



Figs. 2. Oviposition behavior of *E. hokkaidonis*. A: antennation on end plug of a host nest. B: progressing with the abdomen raised. C: locating ovipositor tip on the end plug. D: penetrating. E: laying an egg.

cell walls, while she drew while she drew back to the end plug (Fig. 2D). At last her ovipositor was almost concealed in the nest (Fig. 2E). In this posture the female stopped her motion for a while and then the egg seemed to be laid. Whole oviposition sequence took about 3.5-5 minutes. After oviposition, a small hole bored by an ovipositor was detected on the end plug and cell walls of the nest.

**Description.** *Egg.* (Fig. 3A, B). 3.2 mm long and 0.35 mm wide. Elongate and weakly curved throughout its length, tapered toward bluntly pointed both ends, yellowish white. In size and shape no difference was detected in the comparison with ovarian egg described by Iwata (1958).

*Final instar larva* (Fig. 4). Dorsal part of

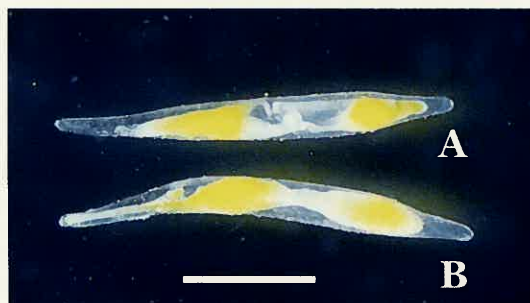


Fig. 3. Egg of *E. hokkaidonis*. A: dorsal aspect. B: lateral aspect. (Scale: 1.0 mm)

hypostomal spur (hsp) a little wider than that at the middle part. Ventral part of labial sclerite (lbs) weakly pointed medially, with weak lobes. In these features the larvae of *E. hokkaidonis* almost agree with that of *E. manifestator* described by Short (1978) except for lobes of labial sclerite smaller in the present species.

*Adults female.* In addition to the original description (Uchida, 1928) of the species, some features are described as follows. Mandible long and rather strongly tapered apically, with lower tooth a little broader and distinctly longer than upper one. In hindwing vein Cu between M+Cu and cu-a as long as or a little longer than cu-a. Metasomal tergite 1 about 1.35 times as long as its apical width in dorsal view, with spiracles at basal 0.4, and a pair of dorsal carinae which are convergent to the middle and faded out at basal 0.4 of the tergite. Metasomal sternite 1 not extending or just reaching to the spiracle of the tergite 1 in lateral view. Tergite 2-5 longer than wide, each tergite rugose-punctate all over except apical 0.3 almost impunctate and polished. Ovipositor (Fig. 2A) very long, about three times as long as forewing, cylindrical, depressed at the apical part (Fig. 5A, B). Upper valve of ovipositor mostly covered

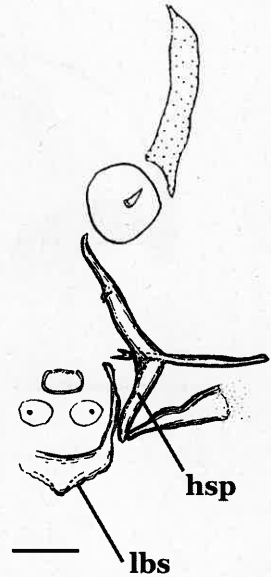


Fig. 4. Cephalic sclerite of final instar of *E. hokkaidonis*. hsp: hypostomal spur. lbs: labial sclerite. (Scale: 0.1 mm)

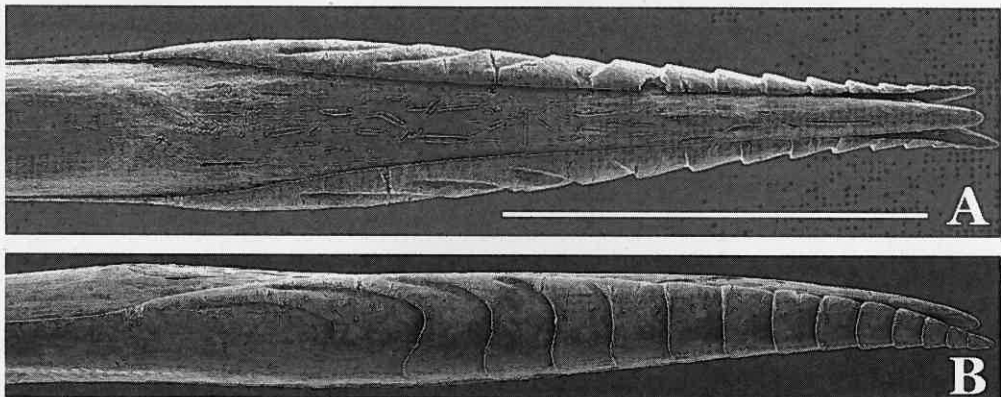


Fig. 5. Ovipositor tip of *E. hokkaidonis*. A: dorsal aspect. B: lateral aspect. (Scale: 0.5 mm)

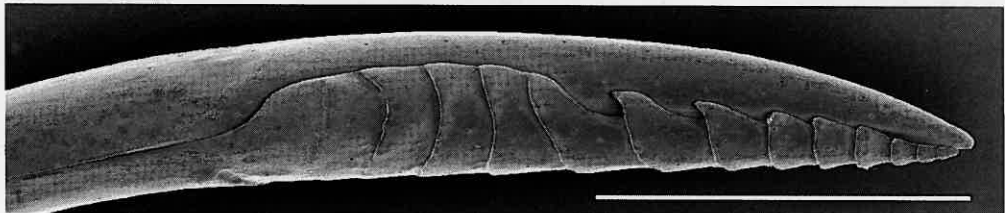


Fig. 6. Ovipositor tip of *Dolichomitus melanomerus macropunctatus*, lateral aspect. (Scale: 0.5 mm)

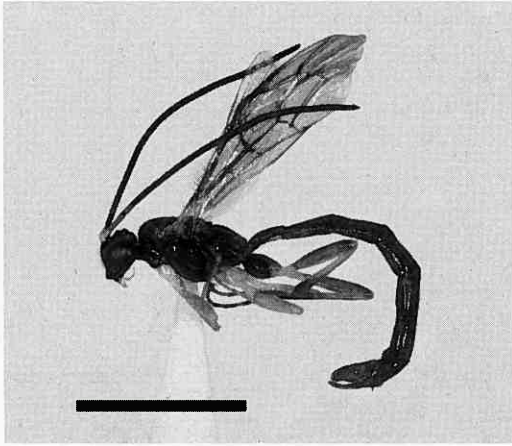


Fig. 7. Male of *E. hokkaidonis*. (Scale: 5.0 mm)

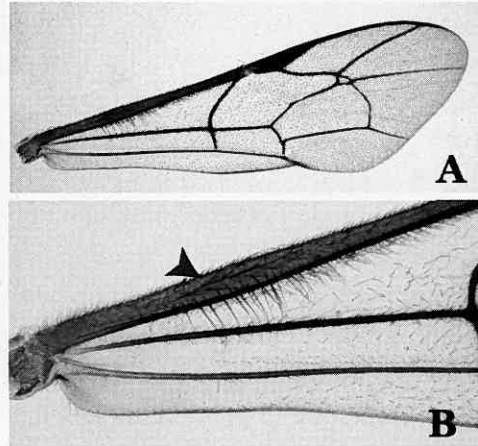


Fig. 8. Male forewing of *E. hokkaidonis*. A: whole forewing. B: basal part of forewing, showing long setae on Sc+R+Rs.

by large dorsal lobes of lower valve except narrow dorsal part. The teeth of lower valve closely set, making a right angle to long axis of ovipositor except basal 4 or 5 teeth of which dorsal edges strongly turns forward at the upper end.

Length: Body (except ovipositor) 12.5-19.2 mm, forewing 8.8-12.9 mm, ovipositor sheath 20.8-43.2 mm.

*Adult male*. The following description is based on a male reared from a *Symmorphus* nest and a field-collected male in the collection of OMNH. Similar to female but different as follows. Smaller with large and distinct parameres (Fig. 7). Face a little longer than in female, 0.75 times as

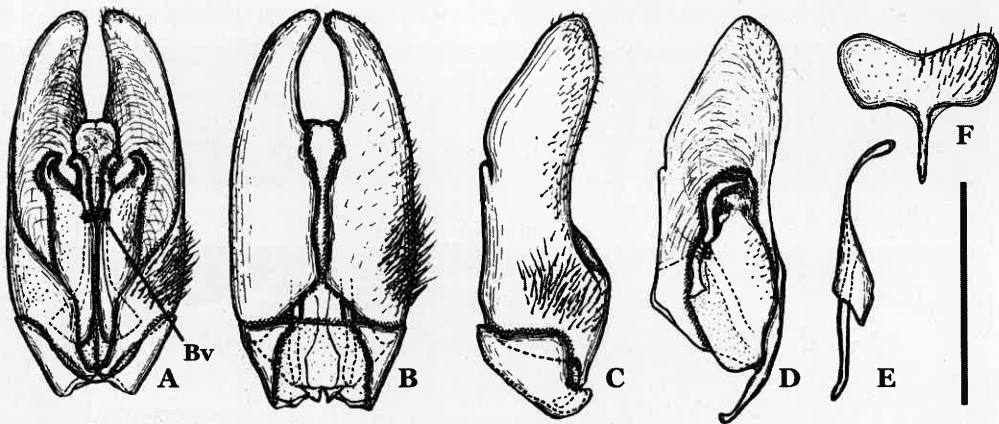


Fig. 9. Male genitalia of *E. hokkaidonis*. A: ventral aspect. B: dorsal aspect. C: lateral aspect (outer view). D: lateral aspect (inner view). E: aedeagus, lateral aspect. F: subgenital plate, ventral aspect. (Scale: 1.0 mm)

long as wide, bearing dense long pubescence all over. Forewings (Fig. 8A, B) with a series of distinct long and erected setae on Sc+R+Rs. Punctures of tergites a little sparser than in female. First metasomal tergite 1.45 times as long as its apical width. Apical 0.3 of tergites 2 and 3 without punctures and polished. Tergite 2 with a distinct oblique groove on each side, that runs from the base toward the spiracle. In tergite 3, these grooves indistinct. Paramere (Fig. 9A) very large, spatulate, bearing dense pubescence ventrolaterally on basal portion of outer side (Fig. 9B, C), in lateral view slightly down curved (Fig. 9C) and with dorsal notch at the middle, with apico-ventral portion weakly inflated on inner side. Basivolsella (Bv) with a mass of pubescence on inner side (Fig. 9A, E). Aedeagus (Fig. 9D) turned downward and thickened apically. Subgenital plate (Fig. 9F) bearing rather dense pubescence and with concave apical margin.

Colouration. Black. Flagellum brown, lighter on underside. Scape, pedicel, clypeus, maxillary pulpus and labial pulpus yellowish white. Wings hyaline, tinged with yellowish brown. Pterostigma of forewing dark brown. Fore and middle legs yellowish, their coxae and trochanters paler. Hindleg: coxa dark brown to black; femur light brown, darkened at both ends; trochanter, trochantellus and most part of tibia yellowish; apical and dorsal part of tibia and tarsus dark brown.

Length: Body 10.9-14.0 mm, forewing 6.0-7.8 mm.

This is the first record of male of *E. hokkaidonis*. This species seemed to be most closely related to Nearctic *E. spatulatus* in the structure of male genitalia.

**Specimens examined:** [Hokkaido] 1 ♀, Ota-higashi, Kushiro Subpref., 20. vi. 2004, R. Matsumoto (R. M.) leg.; 1 ♀, Sapporo, Ishikari Subpref., 8. ix. 1940, H. Aoki leg. [Honshu] 1 ♀, Hirogawara, Yamanashi Pref., 2. viii. 1995, T. Tachi leg.; 1 ♀, Kadoketayama, Shizuoka Pref., 6. x. 2001, R. M. leg.; 1 ♀, Minakoyama, Shiga Pref., 22. v. 1999, R. M. leg.; 1 ♀, Kochidani, Kyoto Pref., 23. v. 1999, R. M. leg.; 1 ♀, Katsuragisan, Osaka Pref., 10. vii. 1966, M. Nakagawa leg.; 1 ♀, Iwakisan, Osaka Pref., 4. x. 2002, R. M. leg.; 1 ♀, Izumikatsuragisan, Osaka Pref., 1. x. 1999, R. M. leg.; 2 ♀, same locality, 30. vii. 2001, R. M. leg.; 1 ♀, Inunaki, Osaka Pref., 5. vi. 2000, R. M. leg.; 4 ♀, Himitani, Hyogo Pref., 4. vi. 2003, R. M. leg.; 1 ♂, (larva) same locality and date, emer. 19. vi. 2003, R. M. leg.; 1 ♀, Akazai, Hyogo Pref., 4. vi. 2003, R. M. leg.; 1 ♀, same locality, 10. vi. 2004, R. M. leg.; 1 ♀, Tsuki, Okayama Pref., 6. v. 1997, Y. Okushima leg.; 2 ♀, Tottori, Tottori Pref., 3. vi. 1970, H. Aoki leg.; 2 ♀, Tsuyutani, Tottori Pref., 31. v. 1940, H. Aoki leg.; 1 ♂, Daisen Tottori Pref., 8. vii. 1994, R. M. leg. [Kyushu (new record)] 1 ♀, Hikosan, Fukuoka Pref., 23. vi. 1996, R. M. leg.; 1 ♀, Momiki, Kumamoto Pref., 6. v. 1999.

### Discussion

**Structure of ovipositor tip and oviposition behavior.** Most members of the tribe Ephialtini are external parasitoids of weakly concealed host such as larvae of Lepidoptera in a cocoon or a leaf roll. The ovipositor tip of these parasitoids are not specialized, with lower valve not forming a pair

of lobe, the teeth of its lower valve slanted and with weak to rather strong nodus. In some of the rest members such as *Dolichomitus*, which attack wood borers, the ovipositor is cylindrical to rather compressed and its lower valve with dorsal lobes which partly enclose upper valve (Fig. 6). These structures are also found in some genera of Cryptinae, that attack wood borers, and seem to be an adaptation to drill through a hard, fibrous and dense substrate to reach host in the bark or wood. In *E. hokkaidonis* the ovipositor tip is cylindrical and somewhat depressed dorsally, the lower valve forming a pair of large lobes which is equipped with close teeth, and almost enclose lateral sides of upper valve from the tip to the basal tooth. These structures were also observed and illustrated in other species of the genus *Ephialtes*, in *E. spatulatus*, (Townes, 1960) and in *E. manifestator* (Linnaeus), (Kolarov 1997). When penetrating the mud end plug of host nest, ovipositor tip was observed to creep into the end plug unless being strongly pressed to it. A tiny hole seemed to be made and spread by the back and forth movement of small teeth of lower valves. The structure of ovipositor tip observed in *E. hokkaidonis* seemed to work effectively not in ripping fibrous substrate for a long distance, but in making a hole and spread it through a rather thin, hard and uniform substrate such as the end plugs or cell walls of dried mud of tube nesting Aculeata nests in above-mentioned manner.

**Host of the genus *Ephialtes*.** As host of the genus *Ephialtes*, a rather wide range of insects was recorded as follows. *Megachile inermis* (Provancher)\* and *M. nivalis* (Fries)\* (Hymenoptera, Megachilidae) for *E. brevis* Morley by Townes & Townes (1960); *Ancistrocerus lineiventris* (Cameron)\* (Hymenoptera, Vespidae), *Ptosima gibbicolis* (Say) (Coleoptera, Buprestidae) and *Tetropium cinnamopterum* (Kirby) (Coleoptera, Cerambycidae) for *E. spatulatus* (Townes) by Townes & Townes (1960) and Carlson (1979); *Pissodes cembrae* and *P. nitidus* (Coleoptera, Curculionidae) for *E. hokkaidonis* by Uchida (1930). In addition to these *Symmorphus* sp.\* was recorded as a host of *E. hokkaidonis* in this study. For *E. manifestator* much wider range of hosts are recorded. However, Fitton et al. (1988) pointed out that "the many published host records must be treated with even more than the usual suspicion because many species of large Ephialtini with long ovipositor have been confused under this name [*E. manifestator*]", host records of this species are excluded from the discussion except a credible record of a male of this species from *Trypoxylon* sp.\* in a trap nest (Fitton et al. 1988). The hosts listed above with asterisks were recorded on direct observation of host. As Townes (1960) pointed out, these records should be considered as being of great value to ascertain a precise host. Although the recorded hosts of the genus are divided into two groups, wood borer and tube nesting Aculeata, all recorded hosts with direct observation belong to the latter. Concerning the structure of the ovipositor tip, oviposition behavior mentioned above and the persistency of female to the end plug of host nest in host location, the regular hosts served for *E. hokkaidonis* and presumably for members of the genus *Ephialtes* seem to be the Aculeate Hymenoptera.



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