Jpn. J. Ent., **63**(3): 541–550. September 25, 1995

Schrankia costaestrigalis (STEPHENS) (Lepidoptera, Noctuidae) Utilizing Underground Spaces

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Abstract The characteristic of using underground spaces through nearly all stages in *Schrankia costaestrigalis* (STEPHENS) is reported for the first time. This species is recorded as a pest of *Vicia faba* L. (Leguminosae) which is cultivated on 3–10 cm diameter blocks of grey lowland soil in Tanegashima Is., Japan. The biology, immature stages and adult are described.

Key words: Noctuidae; *Schrankia costaestrigalis*; biology; immature stages; *Vicia faba*; underground spaces.

Introduction

The family Noctuidae is the largest group in Lepidoptera and approximately 25,000 species is known from the world at present. The noctuid species utilize the undergound spaces in various ways. For example, many noctuid larvae pupate in the soil. Mature cutworms and armyworms hide in the soil during the day and inflict damage on vegetables and crops during the night. However, as was mentioned by AOKI (1973), in Lepidoptera such species known as soil animals are rare because the adults are usually terrestrial and most of the larvae feed on living leaves.

The noctuid adults also use underground spaces in some species. KURATA (1990) reported an interesting habits of *Goniocraspidum pryeri* LEECH. In Nagano City of Japan, there is a long tunnel called "Zouzan-chikagou" which was made during the World War II. The adults of *G. pryeri* emerge at the beginning of summer and go into the tunnel soon, then aestivate and hibernate there sometimes gregariously. And they come out from the tunnel next spring. A similar phenomenon can be also observed in the Australian bogong moth,

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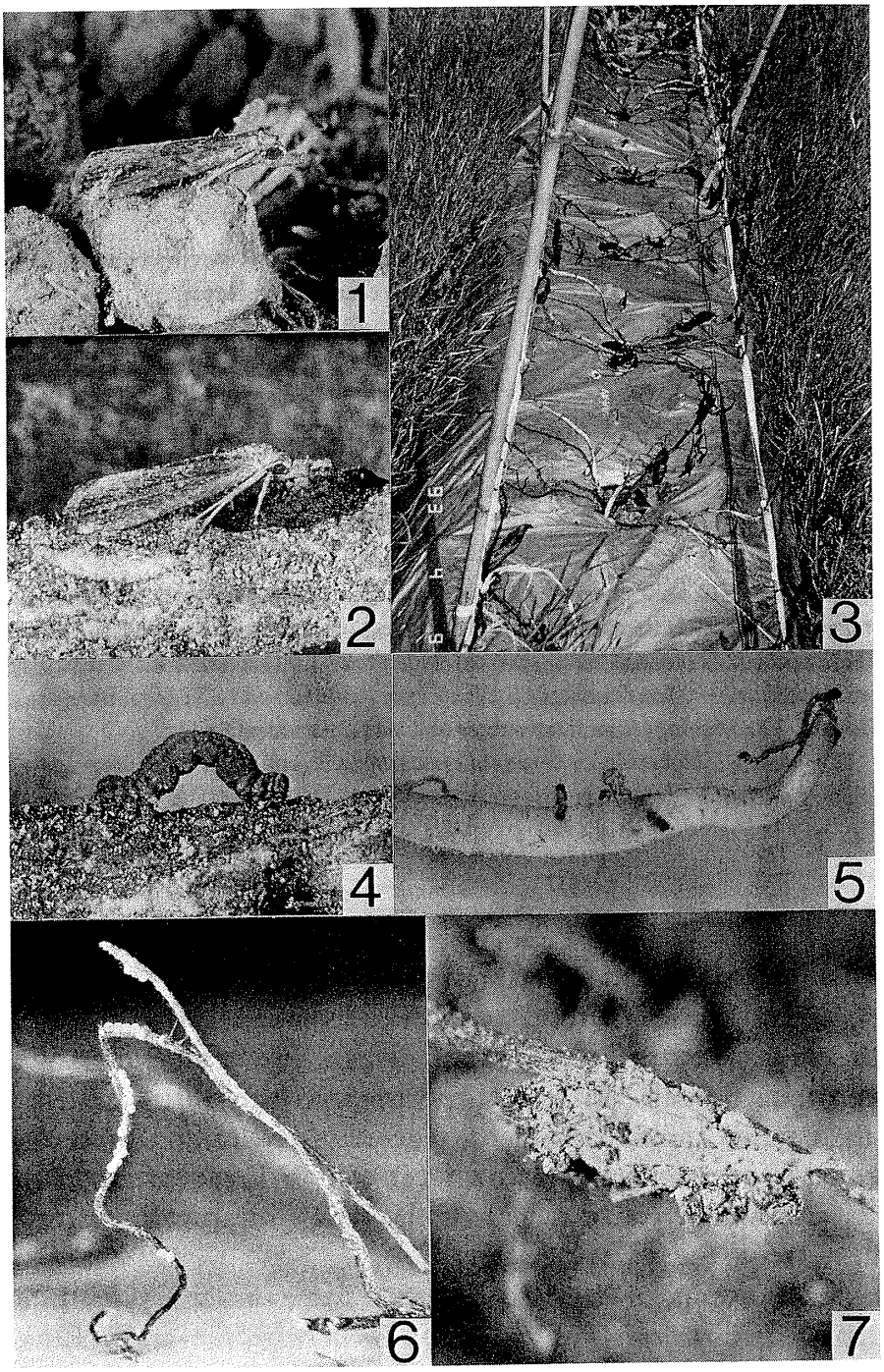
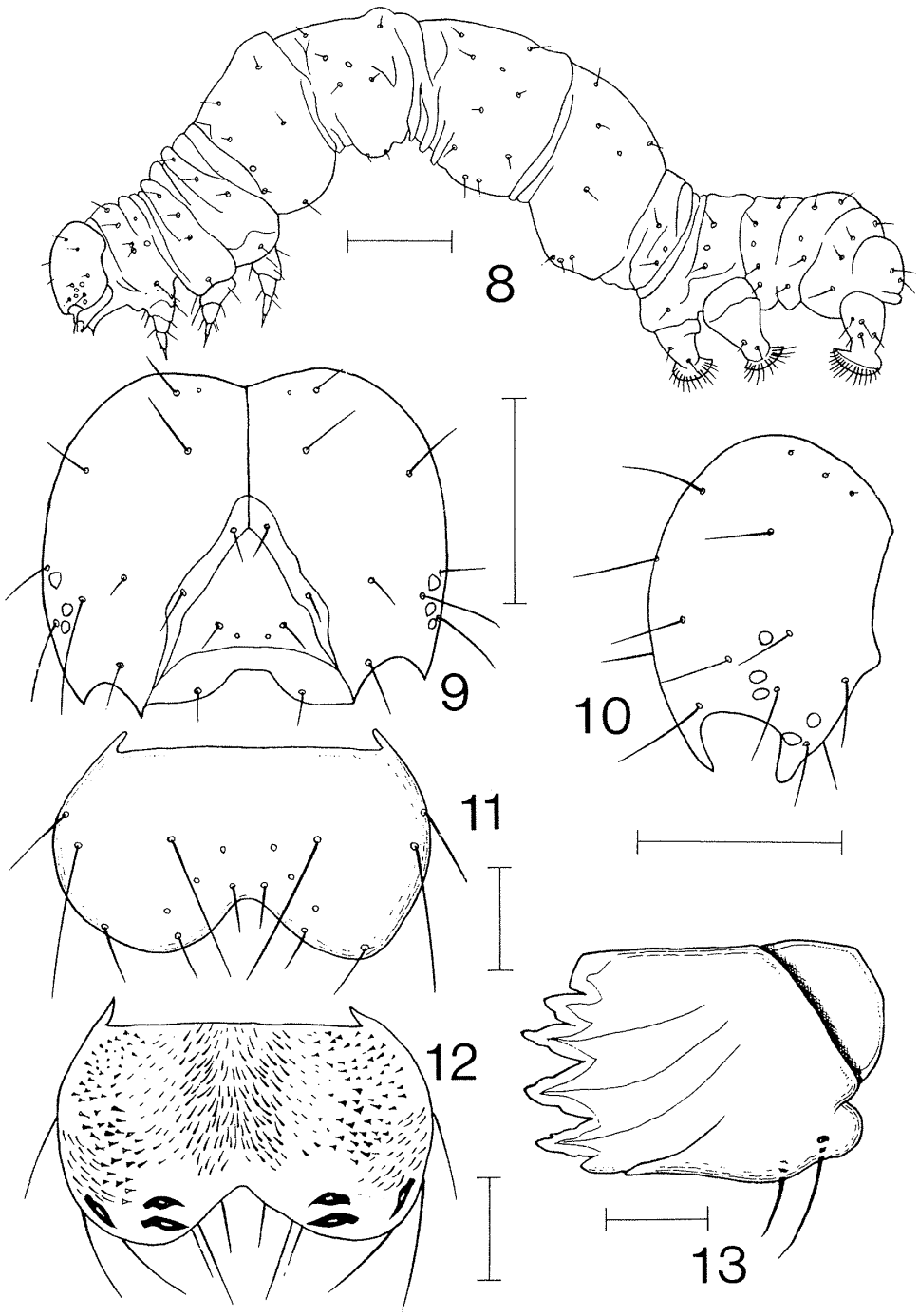


Figs. 1–2. Adults of *Schrankia costaestrigalis* (STEPHENS). —— 1, Resting posture of male; 2, ditto, female.

Fig. 3. *Vicia faba* L. damaged by *Schrankia costaestrigalis* (STEPHENS).

Figs. 4–7. Immature stages of *Schrankia costaestrigalis* (STEPHENS). —— 4, Last instar larva; 5, first instar larvae on the root of *Glycine max* MERR.; 6, eggs on the root of *Vicia faba* L.; 7, cocoon on the root of *Vicia faba* L.



Figs. 8–13. Last instar larva of *Schrankia costaestrigalis* (STEPHENS). —— 8, Larva in lateral view; 9, head in frontal view; 10, head in lateral view; 11, labrum in dorsal view; 12, labrum in ventral view; 13, right mandible in inner view. Scales: 8. 1 mm; 9, 10. 0.5 mm; 11–13. 0.1 mm.

Agrotis infusa (BOISDUVAL). *A. infusa* is a multivoltine species and the spring generation migrate to the mountains, where they aestivate gregariously in crevices and small caves in certain rock outcrops at or near the mountain summits (COMMON, 1952 & 1954).

In the abovementioned moths, they use underground spaces only in a part of their life. In contrast, a small number of noctuid species are known to be utilizing underground spaces during all their life. For example, Hawaiian *Schrankia* sp. is reported to be living in a laba tube during all stages and never go out from the underground spaces. And the larvae feed on living tree roots in the dark zone of laba tube. This species adapts itself so well to the underground spaces of laba tube that the female became flightless and the male became weak fliers as a result of morphological adaptation to cavernicoles (HOWARTH, 1973 & 1983).

Schrankia costaestrigalis (STEPHENS, 1834) is a small noctuid moth (Figs. 1 & 2), which is distributed from Europe, Asia to Australia (SUGI, 1982). And the life history is said to be little known by HEATH & EMMET (1983). Fortunately we could know an interesting biology of this species in Tanegashima Is., Japan. In this paper, the newly discovered characteristic of *Schrankia costaestrigalis*, that of utilization of underground spaces, is reported with descriptions of the immature stages, adult and biology.

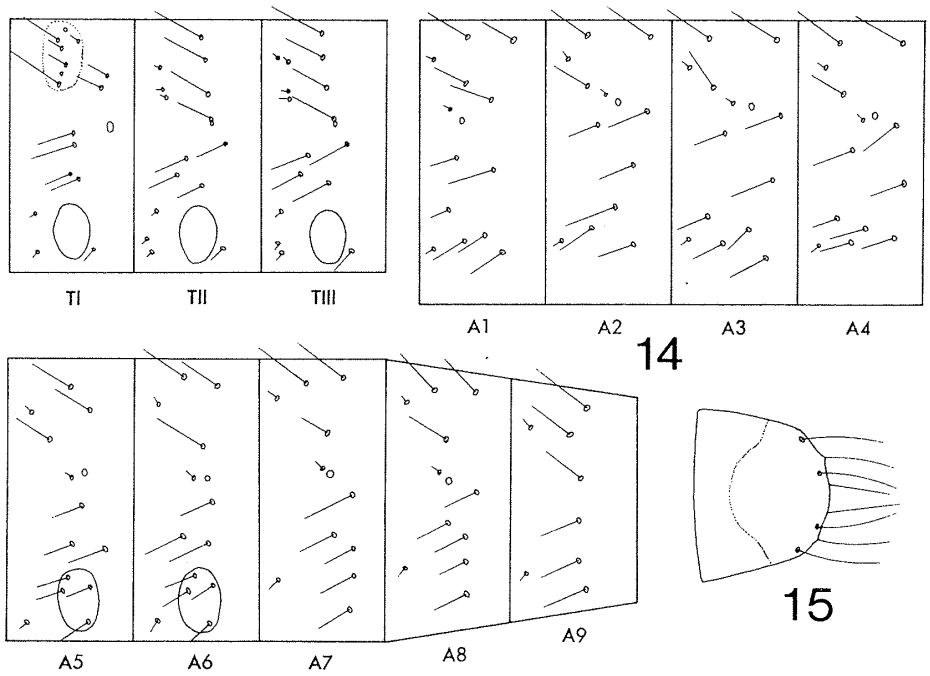
Descriptions of immature stages and adult

Egg (Fig. 6). Diameter: 0.35–0.39 mm. Av. 0.37 mm. (30 specimens examined). Oval and yellowish white. The colour changes to ocherous brown before hatch.

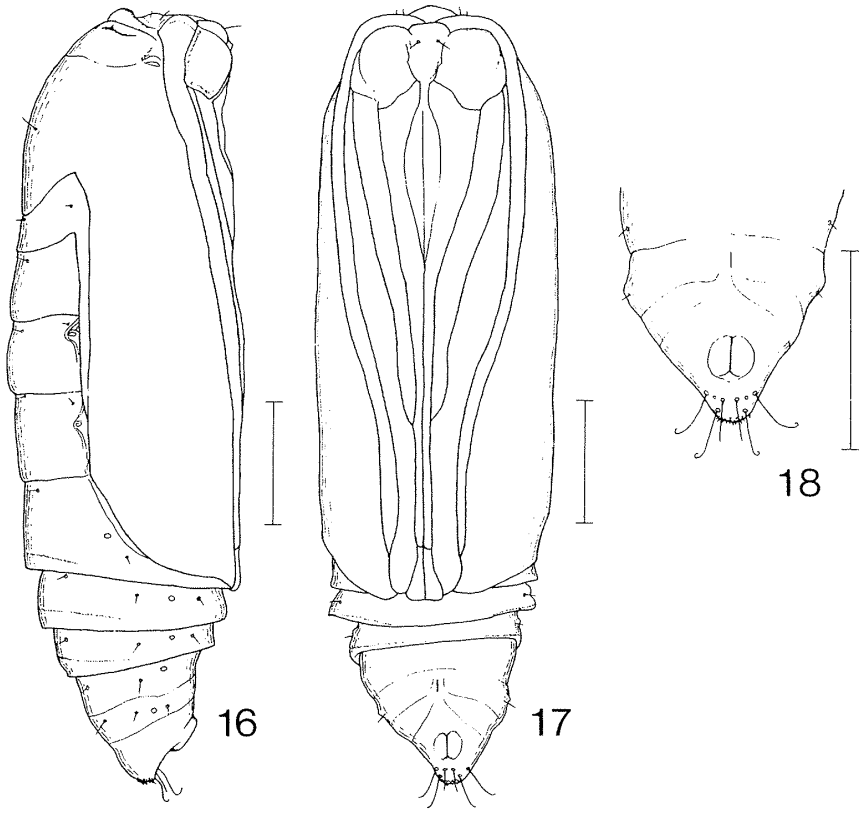
First instar larva (Fig. 5). Body length: 2 mm. (16 specimens examined). Head fuscous brown. Body red. Legs absent on third and fourth abdominal segments. Complete legs present on fifth and sixth abdominal segments.

Last instar larva (Figs. 4, 8–15). Body length: 15 mm. (5 specimens examined). Head and body fuscous brown. Mandible with seven outer teeth. Legs absent on third and fourth abdominal segments. Complete legs on fifth and sixth abdominal segments. Crochets of abdominal legs arranged in lateroseries and uniordinal. Prothoracic shield weak and obscure. D1 and D2 on prothorax short. SD1 on meso- and meta-thorax with a small pinaculum beneath. SV on abdomen 1, 3–6 trisetose; SV on abdomen 2 bisetose; SV on abdomen 7–9 unisetose. Anal shield weak and obscure.

Pupa (Figs. 16–18). Body length: 12 mm. (4 specimens examined). In cocoon (Fig. 7). Tenth abdominal segment with many small serrations on distal end and with three pairs of hairs, of which central one shortest and straight.



Figs. 14–15. Last instar larva of *Schrankia costaestrigalis* (STEPHENS). —— 14, Setal map; 15, tenth abdominal segment in dorsal view.



Figs. 16–18. Male pupa of *Schrankia costaestrigalis* (STEPHENS). —— 16, Lateral view; 17, ventral view; 18, ventral view of caudal abdominal segments.

Adult (Figs. 1–2). Length of forewing: 7 mm. (18 specimens examined). Forewing of male with a distinct white stria from termen. Forewing of female uniformly fuscous brown and without a white stria.

Biology

1. *Damages to plants*

The severe damage to broad bean, *Vicia faba* L. by *Schrankia costaestrigalis* was recognized in December, 1992 for the first time by the second author. However, the damaged areas were restricted to two districts of southern part of Tanegashima Is. where plants on 149 a were damaged. According to the farmers of these areas, a similar phenomenon has been observed from 1990. Broad bean cultivation with vinyl-mulching was done from the end of September to March or April of next year. They rotate crops, *i.e.*, after the broad bean, rice is cultivated from April to August. The larvae feed on the root and root nodule of *Vicia faba* L. and sometimes feed on the stems near the ground surface. The plants will die and fall down when the damage by the larvae was severe (Fig. 3). Such a damage is only seen in the plants which were cultivated

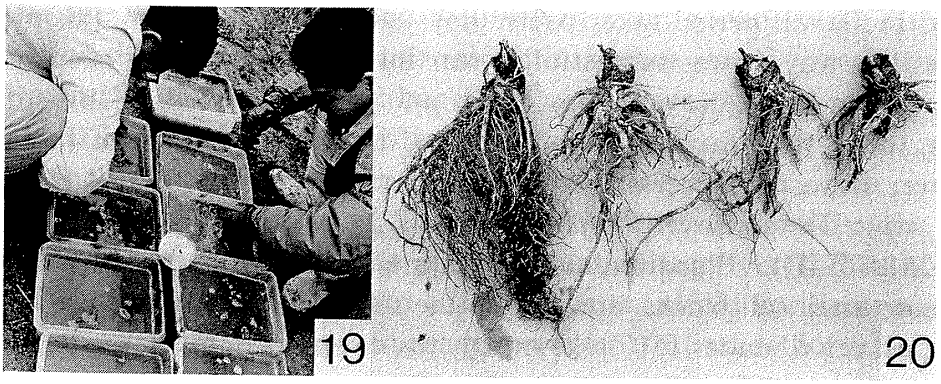
Table 1. Number of each stage of *Schrankia costaestrigalis* (STEPHENS) collected per five roots of *Vicia faba* L. and their surrounding soil[1)] and the degree of damaged roots from October, 1993 to April, 1994[2)] in Tanegashima Is.

Date of survey	Number of larvae			Number of pupae	Number of adults	Total number	Degree of damaged roots (Percentage of cut, main roots)
	Early instar	Middle instar	Mature larvae				
'93. 10/ 1	0	0	0	0	0	0	0 (0)
10/28	0	0	0	0	0	0	0 (0)
11/ 9	2	1	0	0	0	3	I (0)
11/19	0	0	0	0	0	1	I (0)
11/30	2	1	2	0	0	5	I (0)
12/15	6	3	5	0	0	14	I (0)
12/27	2	3	2	0	0	7	I (0)
'94. 1/12	0	6	6	1	0	13	I～II (1.8)
1/24	29	24	26	14	4	97	I～V (23.6)
2/18	20	14	34	6	6	80	I～IV (12.1)
2/28	5	12	10	13	7	47	II～V (32.1)
3/16	157	32	33	15	10	247	II～V (40.0)
4/ 1	82	48	35	25	2	192	II～V (37.8)

Degree of damaged roots. 0: Nothing, I: Slight, II: Small, III: Middle, IV: Big, V: Serious.

1) Concerning the amount of surrounding soil and method of servey, see text.

2) For cultivated period of *Vicia faba* L., see text.



Figs. 19–20. Survey of damage and illustration of damaged roots and non-damaged roots of *Vicia faba* L. by *Schrankia costaestrigalis* (STEPHENS) from October, 1993 to April, 1994. —— 19, Survey of damage using water and pan; 20, left: non-damaged roots; right three: damaged roots.

on 3–10 cm diameter block of grey lowland soil and never seen in those cultivated on sandy field.

In next season, *i.e.*, from the autumn of 1993 to the spring of 1994, as the second author recommended the farmers not to cultivae broad beans on 3–10 cm diameter blocks of grey lowland soil, almost any damages were not recognized except for the damage of 4 a examination field. The degree of damaged roots of broad bean and the number of each stage of *S. costaestrigalis* surrounding the roots were surveyed in this examination field from 1 October, 1993 to 1 April, 1994 (see Table 1). A root of broad bean, with approximately 10 *l* soil at the early plants of the growth and later with 20–30 *l* soil, was dug and the number of each stage of *S. costaestrigalis* and that of damaged and non-damaged main roots were counted after cleaning the soil by water (Fig. 19). The broad beans were transplanted on 28 September, 1993 and stopped cultivation on 8 April, 1994.

As illustrated in Fig. 20, in damaged plants the amount of roots became rather smaller than that in non-damaged plants. Usually one plant of broad bean has 8–20 main roots. In severe damaged broad bean, almost all main roots under 5–15 cm from the ground surface were cut because of the larval feeding. From one plant at most 96 individuals of this insects, *i.e.*, it involves 70 early instar, 9 middle instar and 14 mature larvae, 2 pupae and 1 adult, were collected. Judging from the rearing examination in the laboratory and the data in Table 1, at least two or three generations of *S. costaestrigalis* seem to be performable on broad bean during its cultivation period.

2. *Bionomics*

The larvae live under 0–15 cm deep soil, moving the underground spaces between soil blocks. It is easy to rear the larvae using soy bean sprouts (Fig.

5) and the larval period takes twelve days under 20°C–25°C by this method. Besides this way, it was successful to rear this larvae by adzuki bean sprouts, roots, root nodules, leaves, stems, pods and immature seeds of broad bean. Among them, the leaves of broad bean led the fastest growth of the larvae. However, it was not successful to breed the larvae by perilla (*Perilla frutescens* Britt), white Dutch clover (*Trifolium repens* L.) and artificial diet for silkworm (SILKMATE-II). Pupation takes place in a silken cocoon mixed with plant tissues or small soil blocks, attached to the root or to the soil blocks (Fig. 7). The pupal period under 15°C takes nearly ten days and almost seven days under 25°C.

The adults are usually seen to be walking on the underground soil blocks. On a warm day at the beginning of April, 1994, the moths were observed to be flying weakly between flourishing broad beans, however, maximum one flight was only a few meter. It is not observed yet where they copulate in the field. Using a laboratory dish (60 cm in depth and 9 cm in diameter), broad beans were cultivated on 1–2 cm diameter soil blocks. When several pairs of this moths were released in this laboratory dish, they copulate and later female moths began to deposit eggs on the roots among soil blocks. In laboratory under 25°C, females begin laying eggs after a few days from the emergence and lay sometimes more than one hundred eggs. Hatching takes six days under 20°C. The first damage to plants was recognized in the field at the end of October in 1992. Therefore it seems that the female adults of *S. costaestrigalis* fly to broad bean and lay eggs just after the transplantation which is usually done at the end of September.

Discussion

In Europe this species feed on the leaves and flowers of *Thymus serpyllum* (Labiatae), *Calluna vulgaris* (Ericaceae), *Melampyrum* spp. (Scrophulariacea) and so on (HOFMANN, 1893; BERGMANN, 1954 etc.). However, *Vicia faba* L. is recorded as a host plant of *S. costaestrigalis* for the first time in this paper. Moreover this is the first report on the utilization of underground spaces by *S. costaestrigalis*.

As aforementioned, only a few noctuid moths are known to be utilizing underground spaces through nearly all stages. Although such a characteristic is rare in the family Noctuidae, it is concentrated on the genus *Schrankia* and its relative. The case of Hawaiian *Schrankia* sp. was already mentioned. In addition, the larvae and cocoons of *Protoschrankia ijimai* SUGI were discovered on the roots of trees penetrating through the upper surface of the tunnel in Mie Prefecture, Japan. Although the detailed biology of this species has not been known, this species seems to be well adapted to the underground dark place

(SUGI, 1985). *Protoschrankia* was established by SUGI (1979) and considered to be a close relative of *Schrankia*.

Judging from the fact that in the family Noctuidae the utilization of underground spaces through nearly all stages is concentrated on the genera *Schrankia* and *Protoschrankia*, it is suggested that the members of these two genera potentially have such a characteristic. The adults of *S. costaestrigalis* are seen from April to October in mainland of Japan (SUGI, 1982). The damage to broad bean by *S. costaestrigalis* in Tanegashima Is., likely happened to occurr because of the unique cultivation by mulching and the large blocks of soils. As the biology of other species of *Schrankia* and *Protoschrankia* have not been known well, it should be carefully surveyed. Enough attention should be paid to their biology hereafter.

Acknowledgements

We are grateful to Miss Isoko HATTORI and Dr. Osamu SAITO of the National Institute of Agro-Environmental Sciences, Tsukuba for their critical reading through the manuscript of this paper. We thank Dr. Ichiro TANIYAMA of the National Institute of Agro-Environmental Sciences, Tsukuba for identification of the soil in Tanegashima Is.

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(Received October 11, 1994; Accepted February 6, 1995)

支部活動報告

東海支部報告　第128回例会が応動昆東海支部との共催で平成6年12月10日名古屋女子大学で開催され，以下の講演があった．

1) 上野高敏（名大・農）：新しく発見された，外部寄生蜂の寄主受け入れに関する2つの重要な要因．2) 市岡孝朗（名大・農）：ルビーロウムシの集合性の意義—利己的な群れ，アリの随伴，寄生蜂．3) 米田昌浩（三重大・生資）：コマルハナバチの餌運搬量と外役日数との関係．4) 森　勇一（三重大・生資）：昆虫化石による先史～歴史時代の古環境の復元．

第129回例会が応動昆東海支部との共催で平成7年3月4日に岐阜大学農学部で開催され，以下の講演があった．

1) 大口セツ（岐阜大・農）：カキクダアザミウマの生態．2) 菊井裕人（岐阜大・農）：マコモに寄生するニカメイチュウの生態．3) 水野雅之・市岡孝朗（名大・農）：ヒラタアブ類幼虫の群集構造と種内・種間競争について．4) RAHMAN, T. & T. MIYATA（名大・農）：Responses to synthetic sex pheromone in chlorfluazuron susceptible and resistant diamondback moth males. 5) 宮嶌成壽・王　学英*・小林　淳（三重大・工，*藩陽農大）：中国東北部におけるサクサンの微生物病害の実態について．6) 王　学英*・小林　淳・宮嶌成壽（*藩陽農大，三重大・工）：サクサン核多角体病ウイルスのクローニングおよびその性状解析．7) 近藤正勝・山田佳廣（三重大・生資）：捕食寄生虫クロハラカマバチにとってのヒメトビウンカ各齢の寄主としての価値．8) 宮本啓一・山田佳廣（三重大・生資）：クロハラカマバチの過寄生の特徴．9) 田中紀光（岐阜大・農）：ナミテントウの脳神経分泌細胞の生殖・休眠支配．10) 森　　崇（岐阜大・農）：ナナホシテントウの休眠に伴うJH活性の変化．