SHORT COMMUNICATIONS

A Possible Reason for the Decrease of the Number of Teratocytes in the Body Cavities of *Pieris rapae crucivora* BOISDUVAL (Lepidoptera: Pieridae) Parasitized by *Apanteles glomeratus* L. (Hymenoptera: Braconidae)^{1,2}

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It is well known that teratocytes are observed in the haemolymph of hosts parasitized by braconid parasitoids (GERLING and ORION, 1973). It has been reported that teratocytes in the body of a *P. rapae* host larva originated from serosal membrane cells of an *A. glomeratus* embryo, and that after hatching of the parasitoid the cells developed in the host body to reach almost 100 μm in diameter at the time of parasitoid emergence (KITANO, 1962, 1965). According to HASHIMOTO and KITANO (1971), *A. glomeratus* released about 120 teratocytes per egg into their host body cavities. Thereafter however, teratocytes decreased through parasitoid post-embryonic development, with 75 of them remaining in the host per egg at the time of parasitoid emergence out of the host. The possibility of the decrease due either to the disintegration of teratocytes themselves or to the ingestion by parasitoid larvae was suggested but not experimentally determined. KITANO (1965) demonstrated an abundant accumulation of fat in teratocytes, but the hypothesis of teratocyte ingestion by parasitoid larvae remained untested.

In a preliminary experiment, some teratocytes were observed in the guts of *A. glomeratus* larvae taken out of hosts collected in the field. It was assumed that *A. glomeratus* larvae possibly ingested teratocytes in the host body cavity. This investigation was aimed at evaluating the effect of the ingestion of teratocytes by parasitoid larvae in terms of the decrease of the former.

MATERIALS AND METHODS

A. glomeratus adult female wasps used in oviposition were obtained from cocoons spun after emergence out of host larvae collected in a cabbage farm in Koganei. The host larvae of 2nd-instar *P. rapae* were exposed to these wasps for oviposition. Thereafter the larvae were reared on cabbage leaves under a 16 hr-light, 8 hr-dark condition at 20°C. From 11 to 13 days after oviposition the treated host larvae were dissected and parasitoid larvae in a middle stage of 2nd-instar were obtained. Subsequently, the parasitoid larvae were dissected and their guts were removed with fine forceps. Peritrophic membranes were then pulled out. Only intact teratocytes in the membrane were counted under a microscope; degenerating teratocytes were discarded.

RESULTS AND DISCUSSION

A hundred and ten parasitoids were obtained from five host larvae dissected. A total of 622 teratocytes were found in the guts of the parasitoids, averaging 5.7 (± 4.4 S.D.) teratocytes per larva. Parasitoid larvae contained 0 to 20 teratocytes in their gut, with five teratocytes per larvae being the most frequent (Fig. 1). From these data, the ingestion of teratocytes by *A. glomeratus* larvae has been assumed. However, it is uncertain whether teratocyte ingestion is a function of nutritional demand for parasitoid larvae or if it is incidental to haemolymph ingestion. Feeding by parasitoid larvae on cells originating from the embryonic membrane of parasitoid embryo has been reported by several authors. Those reports can be categorized as follows. Category 1: Trophic function of teratocytes inferred from nutrient accumulation: JACKSON (1924, 1928), LAMPEL (1959), SLUSS and LEUTENEGGER (1968), TREMBLAY (1966), and VINSON (1970). Category 2: Ingestion of teratocytes by parasitoid larvae inferred from quantitative decrease in the host body or from complete disappearance during parasitoids' post-embryonic development; includes HASHIMOTO and KITANO (1971), JACKSON (1924, 1928), SLUSS (1968), SMITH (1952), SPENCER (1926), and VINSON (1970). Category 3: Trophic function of teratocytes inferred from direct observation of parasitoids' guts; includes

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Fig. 1. The frequency distribution of the number of teratocytes in the gut of middle 2nd-instar *A. glomeratus* larvae. N: sample size.

GERLING and ORION (1973), JACKSON (1928), and SLUSS (1968). Category 4: Ingestion of teratocytes by parasitoid larvae inferred from suctorial type mouthparts: includes SMITH (1952). Category 5: Ingestion of teratocytes by parasitoid larvae actually observed *in vitro*: Includes SCHLINGER and HALL (1960). With regard to both trophic function of teratocytes and their ingestion by parasitoid larvae, all these reports are qualitative. The present report is the first quantitative investigation.

According to HASHIMOTO and KITANO (1971), up to 45 teratocytes disappeared from their host body cavities during post-embryonic development per larva in an *A. glomeratus*-*P. rapae* system. In our study, the average number of teratocytes observed to be ingested by a parasitoid larva was much smaller (5.7). Only intact teratocytes were counted. In parasitoids' intestines, degenerating teratocytes probably undergoing digestion were also observed (Fig. 2). In addition, parasitoid larvae used in this study were in the middle 2nd-instar; the ingestion of teratocytes in the late 2nd-instar was not counted. It is therefore assumed that each *A. glomeratus* larva actually ingests more than 5.7 teratocytes, and that the decrease in the number of teratocytes in the haemolymph of a *P. rapae* host is at least partially due to parasitoid larvae ingestion. However, the possibility of teratocyte decrease due to disintegration is not completely excluded.

SHAPIRO and KHOTYANOVICH (1961) reported that *A. glomeratus* larvae growth in an early instar

Fig. 2. Intact and degenerating teratocytes in a peritrophic membrane pulled out of the gut of a middle 2nd-instar *A. glomeratus* larva. p: peritrophic membrane, dt: degenerating teratocyte, t: teratocyte.

Fig. 3. Granules in the peritrophic membrane of a middle 2nd-instar *A. glomeratus* larva. g: granules, t: teratocyte.

was dependent on the host haemolymph, while the final instar larvae fed on fat body of their host. JUNNIKKALA (1966) also reported that 1st-instar *A. glomeratus* larvae absorbed nutrients through their body wall and 2nd-instar larvae fed on their host's fat body. From these reports 1st-instar *A. glomeratus* larvae were assumed not to ingest nutrients through their mouth, and this was probably the cause that teratocytes were not observed in their guts. In the present study we observed that many granules filled the inside of the parasitoids' peritrophic membranes in a late 2nd-instar (Fig. 3). Immediately before parasitoids' emergence out of their hosts, many granules were observed in the inside of the membrane. SIMMONDS (1947) also observed many granules in the guts of full-grown 1st-stage larvae of the braconid parasitoid *Bracon vulgaris* (CRESS.). Thus it is suggested that it is not only teratocytes that serve as

a food source for 2nd-instar *A. glomeratus* larvae. Whether or not the ingestion of teratocytes is necessary for parasitoids' development remains to be proven.

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Decline of the Chestnut Gall Wasp
Population, *Dryocosmus kuriphilus*
YASUMATSU (Hymenoptera: Cynipidae)
after the Establishment of *Torymus sinensis*
KAMIJO (Hymenoptera: Torymidae)^{1,2}

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The chestnut gall wasp, *Dryocosmus kuriphilus* YASUMATSU, which is now considered to have been accidentally introduced from China into Japan around 1940 (OHO and UMEYA, 1975), is one of the most serious pests of chestnut trees. It is very difficult to control the gall wasp by chemicals because the larva develops in a gall formed in a tree bud. A parasitoid wasp, *Torymus sinensis* KAMIJO, was introduced from China into Japan (MURAKAMI et al., 1977, 1980) and released in 1982 in the Fruit

Tree Research Station (FTRS), which is located in the southern part of Ibaraki Prefecture (ÔTAKE et al., 1984). According to ÔTAKE et al. (1984), 260 mated females were released on 11 Japanese chestnut trees, *Castanea crenata* SIEB. et ZUCC., at FTRS. Since the torymid has only one generation a year—the same as its host—it was one year after release that the parasitoids were confirmed to have become established at FTRS.

From three years before the release of *T. sinensis*, *D. kuriphilus* galls were collected between January and March (spring collection) every year to check the occurrence of indigenous parasitoids, particularly *Torymus beneficus* YASUMATSU et KAMIJO—another torymid very closely related to *T. sinensis* (ÔTAKE et al., 1982). All the galls collected were kept indoors (the temperature was the same as outdoors) or in outdoor shelters in order to observe the emergence of adult parasitoids under natural conditions. Since 1983, *T. sinensis* has been observed emerging from galls of the spring collection at FTRS. As pointed out by ÔTAKE et al. (1984) and ÔTAKE (1987), males of *T. sinensis* are morphologically indistinguishable from those of *T.*

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