identify the species of the fly. The process of hatching is very clear from the present observation. The observation indicates that at the time of maggot emergence the longitudinal lines appear in the form of two ridges along about 1/3 length of the egg. The length and width of the operture made by maggot during its hatching were 0.019 mm and 0.081 mm respectively (Table 1). The operture surrounded by membranous chorion shell turns from white to light brown and then to dark brown soon after hatching (Fig. 9). This was followed by drying up of chorion shell and sealing bar with completion of operculum suture resulting in complete separation of operculum from the chorion shell. On the other hand, in *Phorocera assimilis* the operculum remains attached to chorion even after the emergence of the larva due to incompletion of operculum suture (THOMPSON, 1968). The separation of operculum from the chorion shell in the uzi fly leaves behind a small hole on the dorsal surface of the egg. According to some workers (VINOD Kumar et al., 1992) the uzi maggot emerges out through this hole. The present observations not only disagree their view but confirm that the maggot hatches through the hatching pleat. The egg shell later dislodged from the host body.

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Difference in the Larval and Pupal Periods between Mass-reared and Wild Strains of the Melon Fly, *Bactrocera cucurbitae* (COQUILLETT) (Diptera: Tephritidae)[1]

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In mass-rearing for the sterile insect technique (SIT), rapidly growing insects are selected for efficient insect production in some stages. As a result, the pre-oviposition period of laboratory-reared Mediterranean fruit fly, *Ceratitis capitata*, was shorter than that of the wild fly (RÖSSLER, 1975; VARGAS and CAREY, 1989), and a similar difference was also observed in the Oriental fruit fly, *Dacus dorsalis*, (MITCHELL et al., 1965). Mean generation time of laboratory-reared flies was also shorter than that of wild flies in the Mediterranean fruit fly (VARGAS and CAREY, 1989). Recently, ECONOMOPOULOS (1992) reported that the larval period of laboratory strain of the Mediterranean fruit fly was shorter than that of wild flies.

In the eradication program of the melon fly, *Bactrocera* (=*Dacus*) *cucurbitae* (COQUILLETT), in Okinawa, flies have been mass-reared artificially for many generations in the fly factory by the methods described in NAKAMORI and KAKINOHANA (1980), KAKINOHANA (1982), and NAKAMORI et al. (1992) for SIT. Durations of some life stages have been selected for shorter direction intentionally in the mass-rearing procedures of each generation for

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efficient insect production. Actually, pre-mating period, pre-oviposition period, age of peak fecundity, post-oviposition period and longevity of mass-reared flies were shortened compared with these processes in wild flies (see review in MIYATAKE and YAMAGISHI, 1993).

In the mass-rearing factory in OKINAWA, slowly-developing larvae which remain in their medium on the sixth or seventh day after seeding of the eggs, are removed in each generation (NAKAMORI and KAKINOHANA, 1980; NAKAMORI et al., 1992). NAKAMORI et al. (1978) showed that the frequency of retention in the media on the seventh day after seeding of the eggs was 2.3% of all larvae. This rearing procedure may favor shorter larval periods. There is no comparison of larvae and pupal durations between wild and mass-reared flies in the Mass Rearing Facilities of the Okinawa Prefectural Fruit Fly Eradication Project Office.

In this study, the larval period and pupal period in the mass-reared strain of Okinawa Prefecture were compared with those of a wild strain to detect the effect of artificial selection for rapid growth that has been favored in the mass-reared melon flies.

MATERIALS AND METHODS

Insects. Mass-reared strain flies (MS) were obtained from a stock culture that had been reared for 40 generations in the Okinawa Pref. Fruit Fly Eradication Office according to the method described by NAKAMORI and KAKINOHANA (1980), KAKINOHANA (1982), and NAKAMORI et al. (1992). Wild strain flies (WS) were obtained from a stock culture that had been maintained for 6 generations since collection from Ishigaki Island, from March to May, 1989; they were reared by the same methods as MS except for rearing on pumpkin as larval diet.

Design of experiment. Females (about 20 d after emergence) of each strain were allowed to lay eggs in artificial oviposition cylinders (SUGIMOTO, 1978) for 1 h. Two hundred collected eggs of each strain were placed on 60 g of the medium (KAKINOHANA et al., 1975) in a plastic cup (120 ml). Three cups were placed separately in each sample container (dia. 150 mm, ht. 92 mm) filled with water (80 ml). Mature larvae which had jumped out from the medium into the water were transferred to a plastic cup (120 ml) containing a pupariation substrate consisting of a 7: 1 mixture of sawdust and water. The mature larvae pupated within 1 d after jumping. Number of mature larvae in the water were counted at 8: 00, 12: 00 and 16: 00 every day. The duration from egg to mature larvae was defined as a larval period. Emerged adult flies were sexed and counted every evening, because the emergence of the melon fly occurred intensively in the early morning (TANAHARA, 1989). The duration from egg to adult emergence was defined as development period. The experiment was conducted at 25±2°C and under 14L–10D photoperiodic cycle (light phase: 5: 30 to 19: 30).

Statistics. Three cups were used for each strain. As statistical method, "contrasts" was used to test the difference between the 2 strains (MEDDIS, 1980), because there may be uncontrollable differences in conditions between cups in the melon fly (KASUYA, 1992). This method does not consider these differences within each strain.

RESULTS

Quantifying the degree of variation between cups was performed by using the data of the development period. There was a significant difference in development period between cups (Kruskal-Wallis test, $H=5.06$, n.s. for MS males, $H=18.39$, $p<0.001$ for MS females, $H=0.15$, n.s. for WS males, $H=0.82$, n.s. for WS females). The result showed the uncontrollable difference in development period among cups and thus the validity of the statistical method.

Figure 1 is the frequency distribution of the larval periods of the 2 strains based on total number

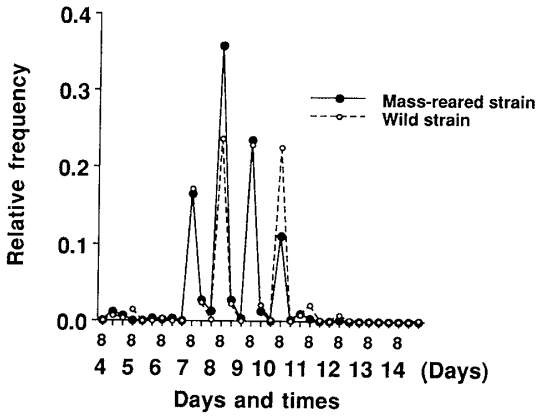

Fig. 1. Relative frequency of larval period of MS and WS. Figure drawn on basis of total number of larvae obtained in 3 replicates.

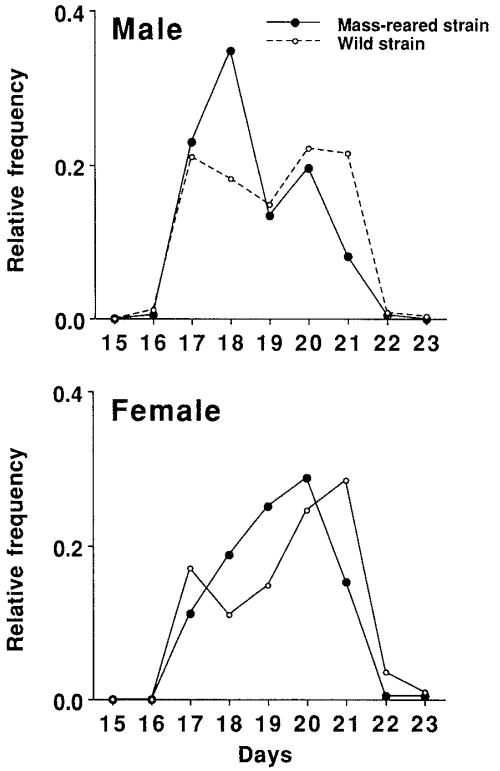

Fig. 2. Relative frequency of development period of MS and WS. Figure drawn on basis of total number of flies emerged in 3 replicates.

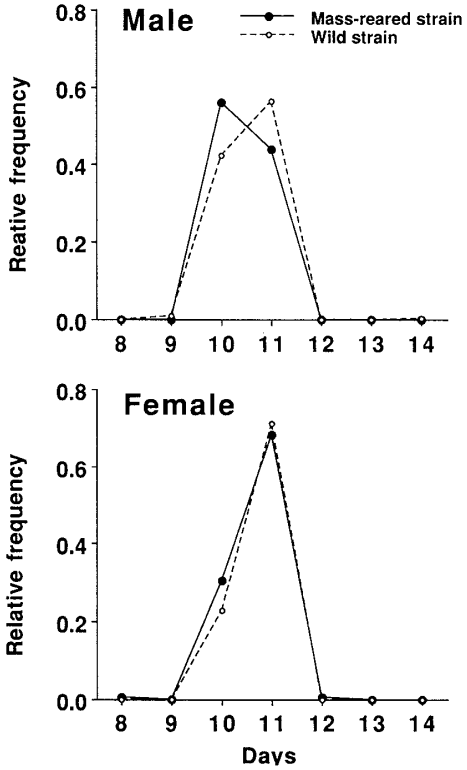

Fig. 3. Relative frequency of pupal period of MS and WS. Figure drawn on basis of total number of pupae obtained in 3 replicates.

in 3 replicates. The total number of mature larvae in 3 replicates was 468 in MS and 510 in WS. Almost all larvae were collected at 8:00 (87.8% for MS; 90.8% for WS). The median of larval period was 8 in MS and 9 in WS. The medians of larval periods of MS were significantly shorter than that of WS ($z=4.215$, $p<0.001$, by MEDDIS, 1980).

Figure 2 shows the frequency distribution of the development periods based on total number of 3 replicates in the 2 strains. The total number of male flies emerged in 3 replicates was 209 in MS and 243 in WS. The total number of female flies emerged in 3 replicates was 208 in MS and 229 in WS. The median of development period was 18 in MS and 19 in WS in male, and it was 19 in MS and 20 in WS in female. The medians of development periods of MS were significantly shorter than that of WS in both sexes ($z=3.506$, $p<0.001$ for males, $z=2.456$, $p<0.05$ for females, by MEDDIS, 1980).

The pupal period was gained by subtracting larval period from development period individually. Figure 3 shows the frequency distribution of the pupal periods based on total number of 3 replicates in the 2 strains. The median of pupal period was 10 in MS and 11 in WS in male, and it was 11 in MS and WS in female. The medians of pupal period in MS were significantly shorter than that of WS ($z=2.637$, $p<0.01$); however, for females, the difference between them was not significant ($z=0.601$, n.s., by MEDDIS, 1980).

Males had a significantly faster development period than females in both strains (MS: $z=5.226$, $p<0.001$; WS: $z=3.083$, $p<0.01$; by MEDDIS, 1980).

DISCUSSION

The result showed that the larval period of mass-reared flies in the Okinawa Pref. Fruit Fly Eradication Office was shorter than that of wild flies. SUENAGA et al. (1992) showed that EJ-period (period from egg seeding to larval jumping; same as the larval period in this study) of the mass-reared

strain of the Melon Fly Control Project Office of Kagoshima Prefecture was significantly longer than that of flies newly introduced into the laboratory in the mass-production facilities. They detected a response opposite to the result in this study. In the mass-rearing procedure of the melon fly, larvae began to jump on the fifth day after egg seeding, and the peak of jumping was on the sixth day. At both the Okinawa and Kagoshima facilities, most of the larvae that had remained in the medium on the seventh day jumped out of it when they were stimulated by low temperature and water spray. In Kagoshima, the larvae collected on the seventh day were used as parent stock for the next generation (SUENAGA et al., 1992). Kagoshima's mass-rearing procedure favors a longer larval period as long as larvae jump out within the seventh day. On the other hand, the larvae in Okinawa collected from the fifth to the sixth and/or seventh day were used as parent stocks, while larvae remaining in the medium (2.3% of the total) on the sixth or seventh day were removed. This procedure favors a shorter larval period. These different mass-rearing procedures in the 2 prefectures caused different selection pressures and accounts for the difference in results between the 2 experiments.

ECONOMOPOULOS (1992) felt that the increased larval period in wild flies (F_0) relative to that of the laboratory strain of the Mediterranean fruit fly was probably related to physical and chemical differences between the artificial medium and fruits that larvae feed upon in nature. In our study of the melon flies the larvae cultured on artificial medium during 6 generations after introduction from fields were used for WS. Thus the increased larval periods in WS may not be caused by the non-adaptation to the artificial medium. It is expected that the duration of all of the stages of the mass-reared flies generally become shorter than those of wild flies through selection for efficient insect production in the melon fly (MIYATAKE and YAMAGISHI, 1993).

This experiment also clarified that the jumping behavior of larvae occurred intensively in the early morning in the melon fly under the 14L–10D (light phase: 5:30 to 19:30). This is the first report about temporal aspects of jumping behavior in the melon fly. There are reports that in the Oriental fruit fly, *Bactrocera* (=*Dacus*) *dorsalis*, larvae jumped out at around the time of light-on (ARAI, 1975, 1976). This is similar to melon fly behavior.

In this experiment, significant difference in pupal period between the 2 strains was detected only in males. The difference is not explained by the selection in mass-rearing, because pupae have not been under artificial selection (i.e. all emerged flies have been used as parents of the next generation in the mass-rearing method). The pupal period may be affected by larval period or other life-history traits as a correlated response, although such correlated responses are not known.

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Seasonal Changes in the Number and Ovarian Conditions of the Cryptomeria Twig Borer, *Anaglyptus subfasciatus* PIC (Coleoptera: Cerambycidae), Collected with an Odor Attractant[1]

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The cryptomeria twig borer, *Anaglyptus subfasciatus* PIC, is a pest of Japanese cedar (*Cryptomeria japonica* D. DON) and cypress (*Chamaecyparis obtusa* ENDL.) and is widely distributed in Japan (KOBAYASHI, 1985). Although it does not kill trees, staining of wood caused by larval activities seriously reduces its commercial value (MAKIHARA, 1987).

Adults of *A. subfasciatus* frequently visit white or whitish flowers of shrubby plants (SAITO et al., 1987) and feed on nectar and/or pollen. Many volatile components of various flowers were examined for attractiveness to the beetle (IKEDA et al., 1993). Although benzyl acetate, a component of jasmine oil, was found to have a remarkable degree of attractiveness, it attracts many anthophilous insects of various taxonomic groups, as well as the target species (NAKASHIMA et al., 1991). Methyl phenylacetate (MPA), which has a chemical structure similar to benzyl acetate, is more specifically attractive to *A. subfasciatus* and its related species, *Demonax transilis* BATES (NAKASHIMA et al., 1991; IKEDA et al., 1993). The MPA, then, has begun to be used for control of *A. subfasciatus* in Japanese cedar stands (NAKASHIMA et al., 1991).

To be an effective control measure, an attractant should collect as many adults as possible before they begin to reproduce. In other words, if it attracts females after they have laid most of the eggs they could lay during their lifetime, the attractant is not effective. Therefore, we need information not only about seasonal changes in the number of attracted adults, but also about the reproductive status of the individuals attracted. However, such information is still lacking with regard to *A. subfasciatus* and the MPA. We report here on the seasonal changes in the number and sex ratio of *A. subfasciatus* adults collected with the MPA trap and on the ovarian contents of the females, and discuss the effectiveness of the MPA as a control measure against the beetle.

MATERIALS AND METHODS

The attractant MPA in liquid form was absorbed into solid vegetable fat (12-hydroxystearic acid) in a weight ratio of 80% of MPA to 20% of the fat. This made the handling of the chemical easier than in liquid form. We used yellow plastic traps (Sankei Chemicals Co. Ltd.; 42 cm ht. 25 cm dia.) (Fig. 1). Each trap had attached to it a shallow plastic cup containing 50 g of the solidified MPA. Attracted insects were trapped and killed in a pail at the bottom of the trap. The pail contained water with about 0.1% sorbic acid added to prevent

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