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Yasumatsu, Keizo

Taketani, Akihiko

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SOME REMARKS ON THE COMMONLY KNOWN SPECIES OF THE GENUS *DIPLOLEPIS* GEOFFROY IN JAPAN*

By

Keizo YASUMATSU and Akihiko TAKETANI

PART I. TAXONOMIC NOTES

(By K. Yasumatsu and A. Taketani)

Diplolepis japonica (Walker), **comb. nov.**

Rhodites Japonicus Walker, Cistula Entom. 1: 309, ♀, 1874 (Japan).

Rhodites japonicus: Dalla Torre, Cat. Hym. 2: 127, 1898 (As. : Japonia).

Rhodites japonicus: Dalla Torre et Kieffer, Das Tierreich 24, Cynipidae : 713, ♀, 1910 (Japan).

Cynipidae Monzen, Ann. Rep. Saito Ho- on Kai 5 : 333, fig. *42,* gall, 1929 (Japan : Morioka. Host plant: *Rosa rugosa).*

Rhodite (sic) *japonica*: Shinji, Insect World 45: 258, ♀ gall, 1941 (Japan. Host plant : *Rosa rugosa*).

Rhodites japonica: Sakagami, Mushi 24 : 71, 1952 (Japan : Honshu. Host plant: *Rosa rugosa*).

Rhodites hakonensis Ashmead, Jour. N. Y. Ent. Soc. 12 : 82, ♀, 1904 (Japan : Hakone). **Syn. nov.**

Rhodites hakonensis: Dalla Torre et Kieffer, Das Tierreich 24, Cynipidae: 713, ♀, 1910 (Japan: Hakone)

Rhodites japonica: Monzen, Ann. Rep. Saito Ho-on Kai 5, 332, fig. 40, gall, 1929 (Japan : Morioka. Host plant: *Rosa multiflora*).

Rhodite (sic) *hakonensis*: Shinji, Insect World 45 : 259, ♀ gall, 1941 (Japan. Host plants : *Rosa multiflora*, *Rosa* spp.).

Rhodite (sic) *hakonersis* (sic) : Shinji, Chuei to Chuei-Konchu : fig. 3, gall, 421, 1944 (Common throughout Japan. Host plant: *Rosa multiflora*).

* Revisional studies on the Cynipoidea of Japan. III.
Contribution Ser. 2, No. 41, Hikosan Biological Laboratory, Kyushu University, Hikosan.
Contribution Ser. 2, No. 267, Entomological Laboratory, Kyushu University, Fukuoka.

Rhodites hakonensis : Sakagami, Mushi ***24 : 71, 1925*** (Japan: Hokkaido, Honshu, Shikoku, Kyushu. Host plant: ***Rosa*** *multiflora*).

Specimens examined : 1 ♀, ***14.*** iv. 1962; ***13*** ♀♀ ***2*** ♂♂, ***15-17.*** iv. 1963; 1 ♀, ***17.*** iv. 1964, Sasayama, Hyogo Prefecture, A. Taketani leg. 1 ♀, 10. iv. 1959, Kora-san, Kurume City, Fukuoka Prefecture, S. Ide leg. 3 ♀♀, 18. iv. 1966, Mt. Hiko, Fukuoka Prefecture, A. Taketani leg. 1 ♀, 29. iv. 1954, Mt. Wakasugi, Fukuoka Prefecture, K. Morimoto leg. 1 ♀, 28. iv. 1962, Cape Sata, Kagoshima Prefecture, A. Nakanishi leg. 1 ♀, 29. iv. 1962, Cape Sata, Kagoshima Prefecture, T. Naito leg.

In 1956, Prof. C. Watanabe kindly examined the type specimen of ***Rhodites*** *Japonicus* Walker in the Collection of the British Museum (Nat. Hist.) and sent the figure and notes on several important characters of the species to the senior author. In the same year the senior author examined the type specimen of ***Rhodites hakonensis*** Ashmead in the Collection of the U. S. National Museum through the kindness of Drs. Krombein and Burks. After making careful comparison of the types, the taxonomic notes and figures and the original descriptions of the two species, the authors came to the conclusion that ***Rhodites*** *hakonensis* is a synonym of ***Rhodites*** *japonica* Walker. As the original descriptions are too short to recognize the species, we give here a redescription of the female and a description of the hitherto unrecorded male.

♀. Head and thorax black. Two basal segments of antennae, tegulae, legs and palpi reddish brown. Ocelli pale or dark brown. Eyes black, in some cases their inner margins reddish yellow. Mandibles except tips dark brown. Apex of the 5th tarsal segment somewhat infuscated. Abdomen dark brown; basal two-thirds of the 2nd tergite, hypopygium partly and ovipositor reddish brown, in some specimens tergites all reddish brown with sheath and the posterior part of hypopygium dark brown. Wings hyaline; veins brown, basal vein, 2nd and 3rd abscissae of subcostal vein and 1st abscissa of radial vein darker. Radial cell with a fuscous cloud at base and along the long second abscissa of radial vein, fuscous cloud also surrounding a large triangular areolet, but more faintly. Hind wings with three hooks. Venation as shown in the figure.

Head transverse, slightly wider than thorax and sparsely haired; occiput coarsely punctured, vertex and frons shiny, smooth and scatterly pubescent. Face coarsely rugose, longitudinally elevated in middle and more or less depressed laterally. Clypeus transverse, slightly convex and minutely punctured, anterior margin arcuate. Cheeks coarsely rugoso-reticulate and covered with appressed long hairs. Upper and outer orbits narrowly smooth and shiny. Antennae 14-segmented; two basal segments of antennae sparsely pubescent, and the rest densely pubescent ; 1st segment compressed and swollen; 2nd grobular ; 3rd slightly thicker at apex than base; 4th to 11th or 12th cylindrical. Relative length (width) of each segment of antennae as follows-I : II : III : IV : V : VI : VII : VIII : IX : X : XI : XII : XIII : IV = 6(4) : 5(4) : 14(3) : 11(3) : 10(3) : 9(3) : 9(3) : 7.5(3) : 7(3) : 7(3) : 6(3) : 6.5(3) : 6(3) : 9(3)

Pronotum very narrow, coasely punctured, sparsely haired in the middle, and heavily rugose, densely haired laterally. Mesonotum smooth and pubescent; parapsidal grooves deep ; anterior parallel lines and lateral lines shallow ; median

scutal line faintly present posteriorly. Scutellum longer than wide, heavily carino-reticulate and densely haired, without anterior foveae at base. Mesopleurae broadly smooth, shiny and naked in middle, the rest reticulate and sparsely haired, propodeum foveate, sparsely haired in the middle, and densely haired laterally, with each fovea smooth and shiny.

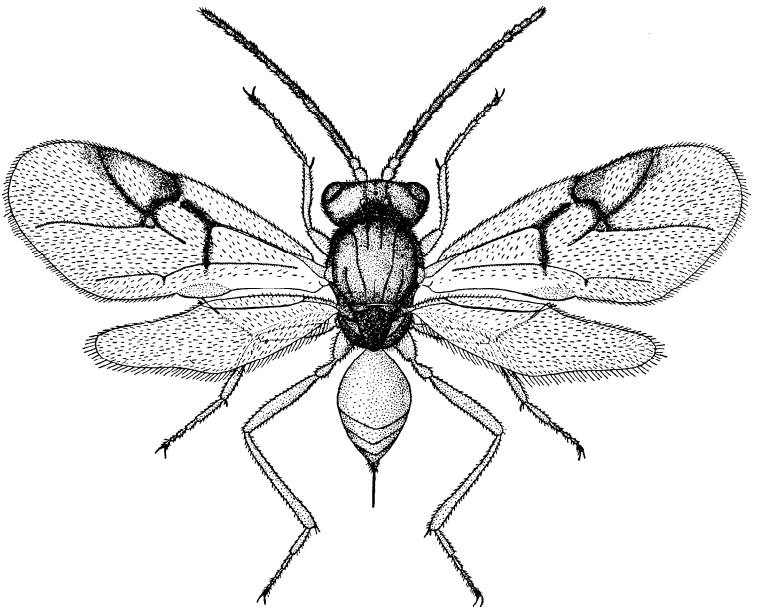


Fig. 1. *Dip'olepis japonica* (Walker), ♀.

Abdomen smooth, shiny and naked ; 6th and the following tergites and underside of hypopygium sparsely haired; 2nd tergite occupying more than half the length of abdomen, posterior margin distinctly inclined. Hypopygial spine sharply pro jected.

Wing densely covered with short microtrichiae, with apical half much denser than basal half; anterior and apical margins of fore-wings and posterior margin of hind-wings fringed with cilliary pubescence. Relative length and width of radial cell about 2 : 1. With width of head used as a base, the length of mesonotum ratio 1.2; antennae *2.5;* fore wing 3.4; ovipositor 1.4.

Length : 3.0-3.5 mm.

♂. Differs from the female as follows : two basal segments of antennae, coxae, trochanters and basal parts of femora fuscous; abdomen black except 1st tergite (petiole) and pennis reddish brown; head, seen in profile, with eyes

slightly wider than cheeks ; stripes narrower along all veins than female ; relative length (width) of each segment of antennae as follows-I : II : III : IV : V : VI : VII : VIII : IX : X : XI : XII : XIII : XIV= 5.5(3.5) : 4(3.5) : 13.5(2.5) : 10.5(2.5) : 9.5(2.5) : 8.5(2.5) : 7.5(2.5) : 8(2.5) : 7(2.5) : 7(2.5) : 6.5(2.5) : 6.5(2.5) : 6.5(2.5) : 8(2.5). With width of head used as a base, the length of mesonotum ratio is 1.37 ; antenna 2.3; forewing 3.4.

Length 2.5-3.0 mm.

Distribution : Japan (Hokkaido, Honshu, Shikoku and Kyushu).

Host plants : *Rosa polyantha* Sieb. et Zucc. (= *R. multiflora*) (Japanese name : No-ibara), *Rosa rugosa* Thunb. (Japanese name: Hamanasu), *Rosa* spp.

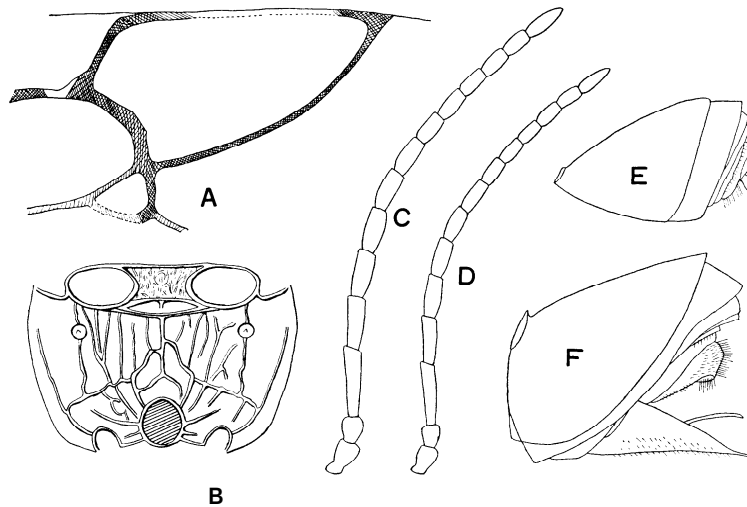


Fig. 2. *Diplolepis japonica* (Walker). A, Radial cell and 2nd cubital cell (Areolet), B, Propodeum, C, Antenna of female, D, Ibid. of male, E, Abdomen (lateral view) of male, F, Ibid. of female.

Description of galls. The commonest type of galls is spherical in shape, monothalamous or one-celled swelling bearing numbers of stout, sharp-pointed spines, which are mostly shorter than the diameter of galls but rarely longer and vary in their numbers from about four to eighteen. The surface is smooth, and covered with fine pubescence only visible under the microscope and sometimes bearing small warts. Usually the galls are arising from the main or secondary axis or petiole of the upper or lower surface of the new leaves of *Rosa polyantha* Sieb. et Zucc., but sometimes from the new seeds or stem of it. The galls are mostly occurring singly but occasionally so in groups of two or three. At first the galls are light-red, tiny and star-shaped. According to the junior

author's investigation, most of the young galls make their appearance from the late May to early June at Sasayama in Hyogo Prefecture. However, some galls were seen from late April to early May. Most of the young galls are bright-red, but in some cases those are tinged with white, rose, pink or green, and the mature galls are tinged with tan or yellowish red. The fully matured galls are shed from the plant to the ground where they remain until the adult insects emerge. The inner cell is large, and the bounding wall of parenchymatous cells is thick, and usually 1.5—2.0 mm. in thickness. Growth is quite rapid and unparasitzed galls reach 8-9 mm. in diameter in June to July. In case the galls have been attaked by the inquiline *Periclistus* spp., the galls are more irregular in shape and contain several smaller cells which are united by spongy tissue with each other, instead of having one large cell as in the healthy galls.

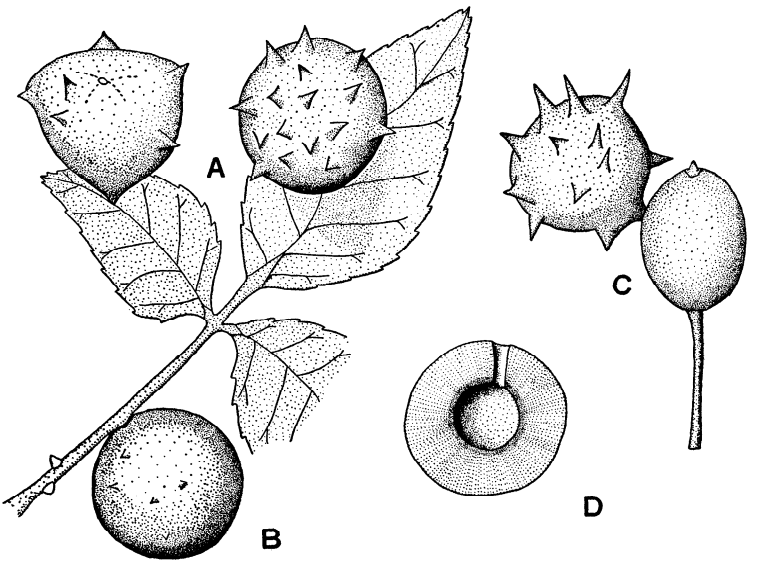


Fig. 3. *Diplolepis japonica* (Walker). A, Galls on the leaf, B, Gall on the stalk of a compound leaf, C, Gall on the new fruit, D, Section of a single gall showing the position of the larval cell and emerging tunnel.

Diplolepis fukudae (Shinji), **comb. nov.**

Rhodite (sic) *fukudae* Shinji, Insect World *45* : *354, 2* text-figs., ♀♂, 1941 (Japan : Hachinohe).

Rhodite (sic) *fukudae* : Shinji, Chuei to Chuei-Konchu: *144, 424, 1944,* ♀♂ gall.

Rhodites (*Nipporhodites*) *fukudae* : Sakagami, Mushi 19: 34-36, ♀♂, 1949 (Japan: Aomori. Host plant: *Rosa rugosa*).

Rhodites fukudae: Sakagami, Mushi 24: 72, 1952 (Japan : Honshu. Host plant : ***Rosa*** *rugosa*).

Specimens examined : Galls collected on 4. iii. 1959 on Mt. E. Akaishi, Nagano Prefecture by F. Takechi and 36 ♀♀ 18 ♂♂ emerged on 25-26. iv. 1959.

Host plant: ***Rosa*** *acicularis* Lindl. var. *nipponensis* Koehne (Japanese name: Takane-ibara). New host record.

In 1959, Mr. F. Takechi sent the material to the senior author for identification. This is the. first record of the species from Central Honshu.

The authors wish to express their hearty thanks to the following entomologists for their kind assistance in various ways: Drs. Karl V. Krombein and B. D. Burks, the late Mr. L. H. Weld, Professors C. Watanabe and T. Ishihara and Mr. F. Takechi.

PART II. BIOLOGY OF *Diplolepis japonica* (Walker)

(By Akihiko Taketani)

The gall caused by *Diplolepis japonica* (Walker) on Rosa *polyantha* Sieb. et Zucc. is very commonly found throughout Japan. It is usually produced on the upper or under surface of the leaves, rarely on the petioles of the compound leaves or on the young fruits during the summer time.

Shinji (1941, 1945) and some other workers reported biological notes of this wasp, but their works were fragmentary and incomplete. The author had a chance-to observe the life-history of the species more indetail. The observations were done at the Entomological Laboratory, Hyogo University of Agriculture from 1962 to 1963 and also at the Hikosan Biological Laboratory, Faculty of Agriculture, Kyushu University from 1965 to 1966.

The author wishes to express his sincere thanks to Dr. S. Kimoto, Hikosan Biological, Laboratory, Kyushu University, for his helpful suggestions and encouragement ; to Professor K. Iwata, Entomological Laboratory, Hyogo University of Agriculture, for his continuous encouragement ; to Mr. H. Masuda, Makioka-cho, Yamanashi Prefecture, and Mr. T. Naito, Entomological Laboratory, University of Osaka Prefecture, for their kind information on the species.

Methods and materials

In 1962, a number of galls were collected when they had dropped from the leaves of the rose plants during the summer season at Sasayama, Hyogo Prefecture. They were preserved in the transparent envelopes to get the wasps in the next year. To estimate the volume of galls, three dimensions (Height, width and length) were measured by the slide calipers. In order to keep the host plants in good condition, about 20 young rose trees were planted in the experimental farm. They were covered with 30 ×30×40 cm. containers with wire netting from the beginning of April to protect them from the attack of

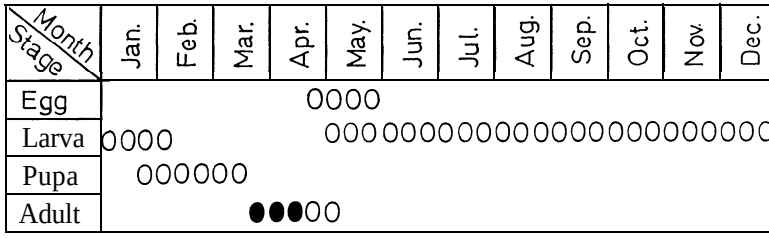
D. japonica or the other injurious insects. In 1963, the adult wasps newly emerged from the previously collected galls were used to investigate the mature eggs, rate of egg-development, oviposition, and oviposition behaviour. Just after the emergence the females were dissected with the help of forceps and sharp-pointed needles under the binocular microscope. The number of ovarioles or ovarian eggs was counted and measured under the binocular microscope.

Life-cycle

The estimated duration of each stage in the life-cycle of this wasp is as follows:

Stages	Duration in days
Egg	7-10, 30-35
Larva	260-290
Pupa	40-55
Adult (inside the gall)	20-30
Adult (outside the gall)	4-5

Table 1. Life-cycle of *Diplolepis japonica* (Walker).



● ..* in the gall.

Adult stage: The adults remain in the galls for a considerable period until the environmental conditions become favourable. Its emergence is often focused to the warm days. Emergence of the adults was ranged from April 25th to May 3rd (from April 25th to May 3rd in the city of Fukuoka, Fukuoka Prefecture, 1966, observed by A. Taketani; third week of April to the beginning of May, Sasayama, Hyogo Prefecture, 1963, observed by Taketani ; April 29th at Cape Sata, Kagoshima Prefecture, 1963, observed by T. Naito; beginning of May at Makioka, Yamanashi Prefecture, 1963, observed by H. Masuda (personal communication).

Mating: In this species, the sex ratio is very high (♀:♂=32:1 in 1963). Most of the females deposit their eggs without mating. Even if the females meet rarely with the males, they show no interest in the sexual behaviour and the mating does not occur.

Oviposition: Females of this wasp were at first released among the young roses with containers in the field. Thus, the wasps were allowed to move freely on the host plants in order to ascertain the portions of plants in which they could oviposit. The female began to oviposit on the tip of the young shoot which is including the young buds of some organs. Later in the day, some of them were transferred into the glass cylinder (Diameter 15 cm., height 22 cm.) in which were set the host plants. As the wasps appear to be highly selective in their choice of oviposition sites, they lay eggs aggressively on the suitable sites, though the sites have already been visited by the other females. The female cleans her body, antennae, legs and wings just after emergence, and flies, wanders or feeds on the hairs of the host plant for several hours before oviposition. The female spends considerable time wandering on the host plants, continuously drumming it with her antennae. If the female can not find any suitable sites to oviposit in the course of testing, she flies off to another part. If she can find the suitable part which is usually newly emerged buds of some organs, she spends much time to examine the host plant again. After having completed her examination, oviposition sites are determined.

The body is elevated and the ventral part of the abdomen is elongated until the tip of the hypopygium touches the plant at an angle of about 70°. Then, the ovipositor is inserted into the tissue by the back and forth movement of her body. The action is at first rapid but slackened toward the end of the movement.

The time used for oviposition is about 2 to 3 minutes. Sometimes, the female takes out her ovipositor after 3 to 5 second insertion without laying any eggs. After making several ovipositions, the female flies off the plant, and wanders around the another part of the host plant or over the ground near it. After wandering for five to six minutes, oviposition is begun again. It seems that the movement before oviposition occupied an important part in the behaviour of this species. According to the author's observations, the female which is confined to a small vessel for several hours does not take the action for oviposition.

***Egg** stage:* As a rule, the galls of Cynipid wasps do not belong to the Procecidia type. It is assumed that swelling of such gall tissues is initiated by the feeding activity of larvae and not by the oviposition of the female. Therefore, emergence of the gall tissue indicates the mark whether the eggs hatch or not. By such conceptions egg period was estimated. The period is the duration from oviposition to the swelling of the site of oviposition.

Ovary and ovarian egg: The ovarian egg is typical of those of most of the Cynipidae. It is composed of a large ovoid body, the egg proper, and a smaller elliptical body, the bulb, and these two parts are connected by a narrow stalk or pedicel. Its colour is milky white. The measurements of the ovarian eggs are as follows:

Length of bulb	0.205 mm.
Width of bulb	0.058 mm,

Length of stalk	0.272 mm.
Length of egg proper	0.321 mm.
Width of egg proper	0.091 mm.
Total length	0.798 mm.

In most of the specimens, the coelom of the body is almost occupied by the ovaries. The number of ovarioles of both sides is conspicuously different from each other, but in a few individuals they have the same numbers. The ovaries are composed of about 55 ovarioles (28 in the left side, 27 in the right side). The average number of eggs in the ovariole is 5.9 (minimum 4.6, maximum 13). In some exceptional cases some ovarioles are keeping only one or two eggs. These facts would suggest that this Cynipid wasp has the reproductive capacity of laying approximately 331 eggs during her short life for about 4.2 days, but in the oviposition experiment only 75 galls were made.

Larval ***and*** *pupal* ***stages:*** These stages were estimated by the dissection of several galls every ten days. It is as yet unkonwn how many instars the larva has. The larvae hibernate in the galls and pupate late in February. The adults emerge from late March to early April.

Table 2. Variation of the number of ovarioles of *Diplolepis japonica* (Walker) and the estimated number of eggs in each individual.

No.	Number of ovarioles			Average no. of eggs in each ovariole *	Estimated no. of eggs
	Right ovary	Left ovary	Total		
1	34	41	75	5.8	435
2	34	30	64	5.2	333
3	17	27	44	6.2	273
4	35	35	70	9.5	665
5	25	20	45	6.7	302
6	23	26	49	4.6	225
7	22	22	44	4.8	211
8	26	23	49	4.7	230
9	29	26	55	5.3	292
10	27	30	57	6.1	348
Average	27.2	28.0	55.2	5.9	331.4

* on an average of 10 ovarioles.

Formation of gall : There are two types in the formation of galls. In the first type, oviposited spots begin to swell as soon as new leaves expand nearly 10 days after oviposition. In the second type, the spots begin to swell nearly 40 days after oviposition. There is, however, no distinct difference in the subsequent development of the galls between the two types.

Coloration of the oviposition spot is green at first, but gradually turns to yellowish green. Approximately 13 days after the start of swelling, the gall begins to erupt through the cortex or epidermis of the leaf vein. The gall size is about 0.5 mm. in diameter, and its colour is yellowish green or whitish green. In most cases, the gall size becomes about 3 mm. in diameter **20** days after the start of swelling, and the spines are visible on the gall surface. Colour is yellowish green. In the field, colour is red, pink, yellowish green or white. After 33 days, the gall attains its maximum size of about 8 mm. in diameter, and the gall tissue is gradually withering up. After 39 days, the gall begins to drop from the attached organ. The drop of the galls ends about on the 55th day.

Shape *and size of gall:* The shape and size of the gall are determined, as a rule, by many factors such as light, gravity, electric currents and hydrogen ion concentration, oxygen tension, concentration of enzymes, hormones, amino acids (Mani, 1964) and the resistance of the plant tissue and nutrients of the soil in which the host plants are planted. The galls which were attacked by the inquilines, *Periclistus* spp., become irregular in shape, and contain several smaller cells which are united with each other by spongy tissue instead of having one large cell as in the healthy galls. The galls which are parasitized by a species of Chalcid flies, *Eurytoma* sp. or *Tetrastichus* sp., remain small, as the gall maker can not feed actively inside the gall.

Summary

Diplolepis japonica (Walker) gives rise to a spherical monothalamous gall on either side of the blade or petiole of the compound leaf, rarely on the younger fruit of *Rosa polyantha* Sieb. et Zucc. In this species, the occurrence of the male is very rare. The ovary and the ovarian egg are typical of those of most of the Cynipidae. The ovaries are composed of about 55 ovarioles. The average number of eggs in the ovaries of one individual is 331. Total length of the egg is 0.798 mm. The life-cycle was estimated by the dissection of galls every ten days. Adult wasp emerges from the third week of April to the beginning of May. The larva hatches either 10 or 40 days after oviposition, thus dividing the egg stage into two types. The galls develop in the beginning of May, and drop on the ground in early autumn. The larvae hibernate inside the galls and begin to pupate late in February.

References

Mani, M. S. 1964. Ecology of plant galls. 434 pp.

Shinji, 0. 1941. Hōsan mosshokushihō-ka *Rhodites-zoku* ni tsuite. Insect. World 45: 66-68.

Shinji, 0. 1944. Chūei to Chūei-Kynchū : 258-272, 395-428.

Explanation of Plates

Diplolepis japonica (Walker)

Plate 1. Female wandering on the shoot of host plant.
Plate 2. Female just before the insertion of her ovipositor.
Plate 3. Female inserting her ovipositor into the host plant tissue.
Plate 4. Female ovipositing her eggs.