A population study in epiphytic Sarcochilus japonicus Orchidaceae

Irina V. Tatarenko[1] and Katsuhiko Kondo[2] : **A population study in epiphytic *Sarcochilus japonicus* (Orchidaceae)**

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Abstract

A population biology of *Sarcochilus japonicus* (Rchb. f.) Miq. (Orchidaceae) is studied. After seeds are dispersed and germinated, they produce protocorms which develop their primary shoot axes elongated and creeped along the surface of substratum and bear firstly tiny scale leaf at the shoot apex and later up to two true-leaves and roots to grow up to a plantlet. Population maintenance and growth of *S. japonicus* occur mostly by sexual reproduction and partially by vegetative reproduction with growing lateral buds in the monopodial shoot. Age spectrum in the population is relatively similar to that of certain terrestrial orchids previously studied. The largest loci of *S. japonicus* are situated on the host boughs spreading to the north to southwest direction, that may depend for further population dynamics on their own ability to use resources of the environment.

Key words : age spectrum, epiphytic orchid, life span, population biology, *Sarcochilus japonicus*.

Much general information regarding the characteristics of population dynamics, reproduction and growth of orchids has been summarized in terrestrial species for past 50 years (e.g., Curtis and Greene 1953 ; Wells 1967 ; Tamm 1972 ; Calvo 1990 ; Gill 1996 ; Tatarenko 1996 ; Neiland and Wilcock 1998 ; Primack and Stacy 1998). The terrestrial orchids are known to have linear and irregular depletion and obscure mortality rate, because they had uncountable, uncertain population sizes of protocorms, one to several years' dormancy periods and recruitment of ramets. These problems in population researches in terrestrial orchids would be resolved if they were studied in certain populations of epiphytic orchids which visualize their entire plant bodies from roots to flowers as well as all ontogenetic stages from seeds to senile plants. Population dynamics, reproduction and growth of epiphytic orchids, however, have been poorly described and characterized in most standard references, excepting a few works on correlations between distribution and host-tree ages (Catling et al. 1986), phorophyte specificity (Ackerman et al. 1989 ; Tremblay et al. 1998) and plant longevity in four species of *Lepanthes* (Tremblay 2000)

have been seen.

Epiphytic *Sarcochilus* R. Br. is widely distributed from Northeastern Australia through Southeastern Asia up to Japan and has the distribution center around the subtropical to tropical Australia and New Guinea (Ohwi 1978 ; Markovina and McGee 2000). Interactions between some species of Australian *Sarcochilus* and mycorrhizal fungi have been reported (Clements 1987). However, knowledge on population biology of the genus is very much lacking.

Sarcochilus japonicus (Rchb. f.) Miq. is one of the commonest, epiphytic orchid species to Japan (Ohwi 1978). The present work is the first attempt of population study in the species.

Materials and methods

The population of *S. japonicus* used in this study was located on a tree of *Pinus thunbergii* Parl. ca 400-years old, ca 10 m tall, 60 cm diameter at breast height and 11 m crown-cover diameter and two surrounding young trees of the same species in Choenji Buddhist Temple on the south-east slope of Mt. Kannon, alt. about 400 m, Fukutomi Town, Hiroshima Prefecture, Japan. The population analysis was made from June,

Table 1. Some components of an epiphytic phytocoenosis on an old tree *Pinus thunbergii* in Choenji Buddhist Temple

Species	Density	Location on tree
Hepaticae		
Lophocolea minor Nees*	1	Trunk, old boughs
Bryophytae		
Leucobryum juniperoideum（Brid.）C. Müll.**	2	Boughs grown to northern direction
Hypnum oldhamii（Mitt.）Gaeg. et Sauert.*	1	Old boughs
Trachycystis microphylla（Dozy et Molk.）Lindb.*	0	Trunk
Sematophyllum subhumile（C. Müll.）Fleisch. subsp. *japonicum*（Broth.）Seki**	3	Trunk, boughs grown to northern direction
Cololejeunea minutissima（Sm.）Schiffn.	0	Trunk
Pylaisiadelpha tenuisostis（Bruch et Schimp.）Buck	1	Boughs
Lichens		
Punctelia rudecta（Ach.）Krog*	1	Boughs grown to northern direction
Dimerella sp.	1	Trunk
Lepraria sp.	1	Trunk, boughs grown to northern direction
Parmotrema tinctorum（Nyl.）Hale*	0	Trunk, thick low boughs
Parmelinopsis minarum（Vain.）Elix et Hale	0	Thick boughs
Myelochroa aurulenta（Tuck.）Elix et Hale	1	Thick boughs
Rimelia reticulata（Tayl.）Hale et Flechter**	3	Thick and thin boughs
Stereolaulon sp.	0	Trunk, near the base

Mosses were identified by Prof. Dr. H. Deguchi, while lichens were identified by Mr. K. Takahashi. *Species connected occasionally with roots of *Sarcochilus japonicus*. **Species connected regularly with roots of *Sarcochilus japonicus*. Density means frequency of plant covering area by certain species on surface of the host tree : 0=less than 1%; 1=1–5%; 2=5–10%; and 3=more than 10%.

2000 until March, 2001. The epiphytic phytocoenosis with *S. japonicus* consisted of eight species of lichens, seven moss species（Table 1）, some algae and one fern.

Conventional morphological analysis was applied to determine shoot morphogenesis. Monopodial shoot was taken as an elementary unit of population study.

Ripe fruits among the fruits produced on 38 plants of *S. japonicus* were counted and harvested. Seed number per capsule was calculated on the basis of 15 ripen fruits randomly chosen.

Age structure of population was detected by using the approach of biological age stages（Rabotnov 1950; Vakhrameeva and Tatarenko 1998）. Plant ontogenesis was classed for the age stages designated as : l=seeds; p=protocorm; p1 =protocorm with the first green leaf; j=juvenile; im=immature; v=virginale; g 1=young generative（sexual mature）; g 2=adult generative; g 3 =old generative; s=senile. Reproductive strategy of *S. japonicus* was analyzed by counting sexually and asexually reproduced individuals. Mycorrhizal infection in cells of *S. japonicus* was studied by a quantitative method（Selivanov

1981; Tatarenko 1995）.

Histological observations in plant tissues of *S. japonicus* were made by the following procedure : Tissues were fixed in 4% formaldehyde overnight at 4℃, dehydrated in a series of 2– methoxyethanol, 100% ethanol, n-propanol, and n-butanol, for 12–16 h, respectively at 4℃, and then infiltrated with monomer mixture solution of 94.5% purified glycol methacrylate, 0.5% 2,2'- azobis, and 0.5% polyethylene glycol 400 for 12 h at 4℃ three times. The samples were, then, transferred to polyethylene capsule, embedded in the monomer mixture at 30℃ for a day, 40℃ for a day, and then, 60℃ for a day in an incubator. The embedded samples were sliced into pieces of 25 µm thickness on a sledge microtome. After being affixed to glass slides, the sections were stained with Toruidine blue.

Results

Germination of seeds and developmental morphology of protocorms

The period of seed ripening（Fig. 1 A）in *S. japonicus* took 7–8 months from April-May to November-December. Capsules dehisced had ex-
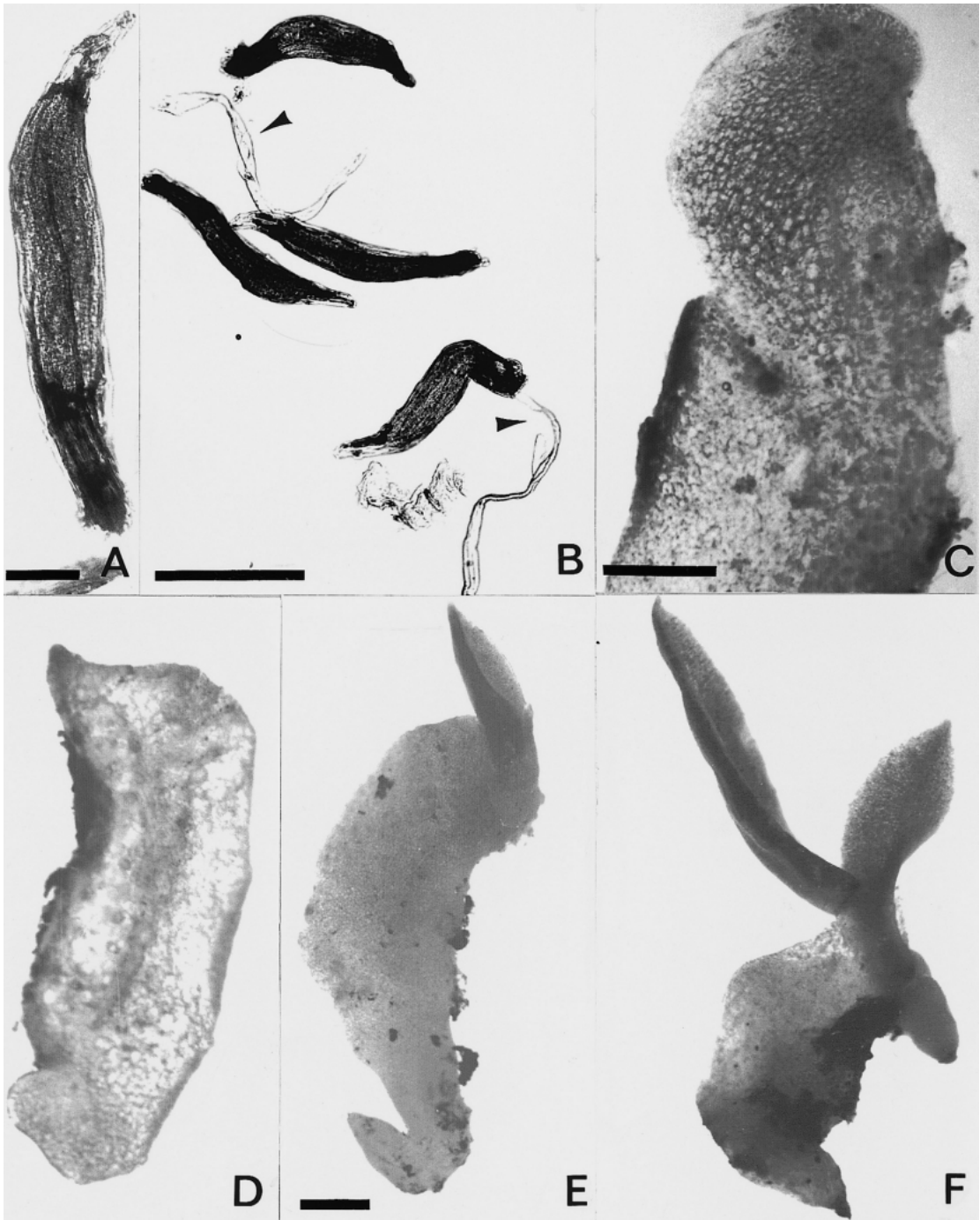
Fig. 1.　Germination and developmental morphology of seeds in *Sarcochilus japonicus*.
　A, A seed. Bar=5 μm ; B, Seeds with specialized fibers (arrowheads) for throwing seeds away from capsule. Bar =20 μm ; C, Apex of a "wing" shaped protocorm. Bar=1 cm ; D, "Wing" shaped protocorm ; E, Growing the first leaf on protocorm ; F, Growing leaves at a tip and two roots at both tips on protocorm at latest stage. Bar for D to F=11 mm.

plosively discharge method of seeds as specialized spiral fibers of them recurved instantly soon after they changed moisture content to get dry (Fig. 1 B). *Sarcochilus japonicus* had relatively high seed production ; 1.4±0.6 ripe capsules per individual plant and 4,500±533 seeds per capsule.

Great many seeds of *S. japonicus* germinated in nature soon after they were dispersed, and then, produced protocorms (Fig. 1 C and D) within a few months. However, some seeds stayed not germinated nearly for a year. Some fertile but non-germinated seeds were attached and found on adult plants of the species.

Protocorms of *S. japonicus* were flat, samara-like in shape on the dorsal side and green in color (Fig. 1 C and D). At the first stage of "p", the primary shoot axis elongated and crept along the surface of substrate (Fig. 1 C and D). Clusters of epidermal hairs strongly attached to the substratum (Fig. 1 C). The shoot apex produced tiny scale leaf (Fig. 1 C and D) just before the beginning of the first true-leaf growth and the first root growth (Fig. 1 E). At the last stage of "p 1", the plant had 1–2 green leaves and 1–2 roots (Fig. 1 F, Table 2). The primary protocorm body died soon after the roots reached up to 1.5 cm length and were stuck on the surface of substratum.

Post-protocorm developmental morphology

Quantitative characters of leaves, monopodial shoots and roots of *S. japonicus* were increased steadily from "j" and "im" to "g" stages (Table 2). Young plants of "j" and "im"stages differentiated easily by lack of dead leaves and roots. From the stages of "vm" to "g 1" lower leaves and roots consequently died. Ontogenesis periodization of "g" age stages was very clear. Plants of "g 1" grew up enough to form one or rarely two inflorescences for their first flowering. Plants of "g 2" retained old, dead dried inflorescences and produced several new flower buds. Plants of "g 3" had only a few leaves on the top, a few old flower stalks and dead shoot apices. Their lateral bud produced sometimes either a new inflorescence or vegetative shoot (Table 2). Plants of "s" had a shoot with 0–2 live leaves and a few live roots.

Reproductive strategy

Adult generative plants produced 3–5 flower stalks per plant after they maintained undeveloped lateral flower buds for 3–4 years. Every inflorescence sets 2–3 flowers.

The vegetative reproduction of *S. japonicus* was made with proliferation of lateral buds. Adult or old generative and senile plants sprouted lateral shoots. In the population studied 1.9% of the adult generative plants, 3.9% of the old generative plants and 3% of the senile plants developed new shoots during the course of investigation. Thus, vegetative reproduction of *S. japonicus* seemed to be an additional means for population maintenance and growth.

Population structure
Age structure

Age spectrum in the population reflected relative ratio of age groups (%) : 12 p : 22 p 1 : 7 j : 3 im : 9 v : 5 g 1 : 32 g 2 : 6 g 3 : 4 s and showed two highest peaks ; one at the "p1" stage which indicated successful seed germination and the other at the "g 2" stage which occurred due to large duration of the stage (Fig. 2).

The population of *S. japonicus* studied consisted of 66 dense groups of plants called loci and 14 separate individual plants (Table 3). Sixteen average-size loci had 3–5 plants each and another 19 average-size loci had two plants. Eight loci bigger than the average had 6–10 plants each, while 22 still bigger loci contained more than ten plants. The biggest locus was composed of 197 plants.

Old loci contained mostly adult generative plants and numerous protocorms. Thus, the well developed loci were characterized by the similar age spectra as the whole population (Fig. 2). In contrast, the individual plants separated from the main loci were representatives of plants at "v" or "g 1"stage. A few isolated protocorms were observed at remote positions from the main loci. Some loci were built up by 1–2 generative plants and 1–3 protocorms or juvenile plants.

Three loci of *S. japonicus* were found on two small neighbouring trees of *P. thunbergii*. One locus on a tree consisted of 1 j : 3 g 2 : 2 g 3 : 4 s, while the other two loci on the other tree consisted of 1 v : 1 g 2 (1 v-dead) and 1 im : 1 v :

Table 2. Morphometric characteristics of age stages in *Sarcochilus japonicus*

Characteristics	Age stages*						
	j	im	v	g 1	g 2	g 3	s
Number of leaves	1–3	3–4	4–6	5–6	8–12	2–3	0–3
Leaf width（cm）	0.2–0.4	0.3–0.4	0.4–0.5	0.4–0.5	0.5–0.6	0.4–0.5	0.4–0.5
Leaf length（cm）	0.3–0.7	1.0–1.3	1.8–2.3	2.0–2.5	2.5–3.2	1.7–2.1	1.5–1.8
Number of live roots	1–3	3–6	8–12	10–18	15–25	5–8	1–4
Root length（cm）	0.5–1.3	2.5–7.0	5.0–10.0	10.0–15.0	10.0–35.0	10.0–15.0	2.0–5.0
Stem length（cm）	0.2–0.5	0.6–0.8	1.3–3.0	2.5–4.0	4.0–8.0	3.0–6.0	2.0–5.0
Number of old flower stalks				0–1	2–8	1–3	
Number of new flower stalks				1–2	4–6	0–1	

* "j"=juvenile ; "im"=immature ; "v"=virginal ; "g1"=young generative or sexually matured ; "g 2 "=adult generative ; "g 3"=old generative ; "s"=senile.
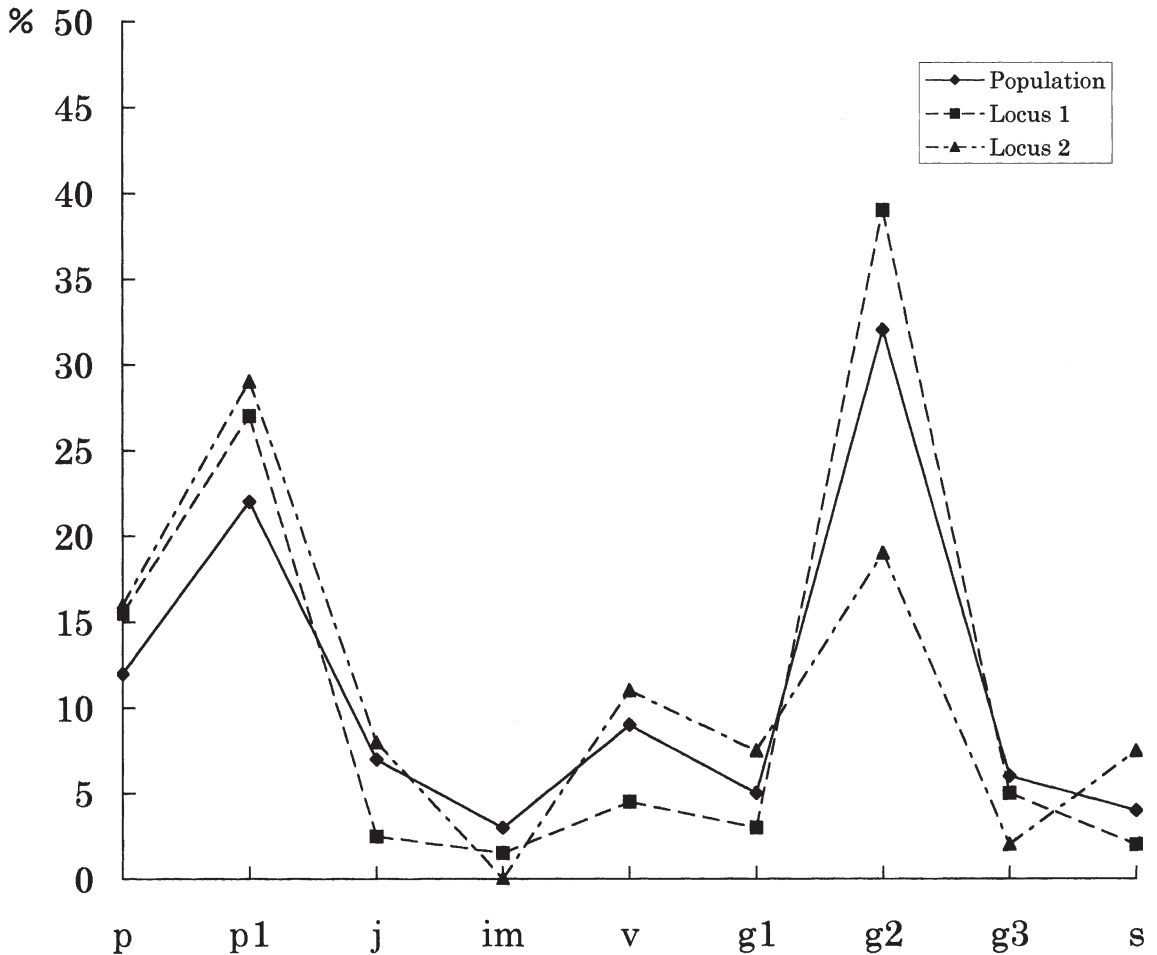

Fig. 2. Age class spectra in the entire population and two largest loci of *Sarcochilus japonicus*.
The symbols for respective stages designate as : "p"=protocorm ; "p1"=protocorm with the first leaf ; "j"=juvenile ; "im"=immature ; "v"=virginal ; "g1"=young generative or sexually matured ; "g 2 "=adult generative ; "g 3"=old generative ; "s"=senile.

Table 3. Disposition of loci and age-spatial structure in the population of *Sarcochilus japonicus* on the host tree of *Pinus thunbergii* in Choenji Buddhist Temple

Part of tree	D	E	H	S	L	p	p 1	j	im	v	g 1	g 2	g 3	s
									Age stage					
Trunk	60	E	1,2	25×75		3	7	5/2	1	1	1	14	1	
I–1 (1)	15	N	0,6	15×10	40	1	3			1		2		
I–1	7,5			14×7	32	3/2	8/1	2/3		1	3	4		
I–1				10×10	30							3	3+5	
I–2	6			5×15	20			1					4+4	1
I–2				5×30	13	6/1				5	2	14		2
I–2	7			5×10	25			1		2	1	1		
I–3	3,5	S–W	0.7	10×10	15			2	1	7		5		
I–3	3				20				1	1				
I–5	2,5			3×5	10	6	3							
I–5	2,5		0,8	5×2	17	1			1	1				
I–6	2				5							1		
I–6					12						2			
I–6					8		1				1			
I–6	2			5×5	12	3/12	12			1		3		
I–6					18					2				
I–6					5					2				
I–7	2			5×5	15	2	1				1			
I–7	1,6				7					2				
I–7					10							2		
I–7				5×5	5	3			2					
I–7				5×5	5		11	1	1					
I–7				5×5	15	12	4	1				1		
I–8				3×5	7	1		4			1	1		
II–1 (3)	12	N	2,1	3×3	25							5	1	
II–5	3										1			
II–7	1,5				30							2		
II–8	2										1			
II–8	2,5			2×2				3				4		
III–5 (4)	3	E	3,5		120							2		
IV–4 (4)	4,6	S	3,7		70						1			
V–1 (3)	13	S	2,6	5×5	30							3	1	
V–1	12			2×2	20						1	5		
V–2	8,5												2+2	
V–2					30								1	
V–5	4,5				70							2		
V–5													3	
V–7	2,5			2×2								5		
V–8	2,5				110						1			
V–8				2×3	80					2		10		
V–8				2×3	20							8+2	3+3	
V–9	2				10							1+2		
V–9				2×8	10			6	7	4				

Table 3. continued

Part of tree	D*	E*	H*	S	L									
V–9					15							2	1	
VI–1 (3)	14	N	2,7		20		3							
VI–1					20								1	
VI–1					10								2	
VI–1					10									2
VI–1					15							1	1	
VI–1					110								2	
VI–1					20								3+1	
VI–1				2×2	50								8	
VI–1				2×2	10							2	3	
VI–2	7							1						
VI–5	4													1
VI–8	2										2			
VI–5,6,7	3–4			50×30						1	5	11	4	
VII–1 (1)	22	S–E	0,9		28							1		1
VII–1					15			1						1
VII–1					5			1						
VII–1					5							1		1
VII–1				25×10	8		3/3	1		5	3	11	4+4	8+1
VII–1					60								1	
VII–1	22	S–W	0,8									1	1	
VII–1				7×3	5	1	2		1					1
VII–1					10						1			
VII–1				2×2	20						2		2	
VII–1				16×6						4	2	8	2	5
VII–2	12			65×5		/5	10	4		4	5	8	10	3
VII–4	5												1+2	
VII–6	3			2×1			2						1	
VIII–1 (2)	24	S-W	1,5	50×10						1		8	2	
VIII–1				5×5	130						1	5		
VIII–2	17			10×5	30				1			13	4	3
VIII–2					15						1			
VIII–5,6,7	1,5–3			30×45		17	23/8	8		12	8	20	2	8
IX–2 (1)	18	N	0,3	5×6		13	17	15	3	3	2	3		
IX–1	26			5×10		4	12			2		12		3
IX–1				10×10	10	3	4	1		1	1	1		
IX–2	17			55×15		30	54	5	3	8	7	77	9	4

In "Part of tree"on the host tree of *Pinus thunbergii*, I, II up to IX represent the accession numbers of the boughs ; -1, -2 up to-9 represent numerical order of boughs ; （1）up to （4）represent number of branch level in crown.
D*=diameter（cm）; E*=exposition（N=north, S=south, SW=southwest）; H*=height of the branch disposition above the ground（m）; S=size of locus（cm）estimated by counting more than 3 shoots per locus ; L=length of intermediate between neibour loci（cm）; p to s=numbers of plants at every ontogenesis stage. See Table 2 for the designations of the symbols. Additionally, the symbol "p" means protocorm.（/5=number of plants situated on the hanging roots ; +2=number of growing lateral shoots）. ＊empty space in 2–4 columns means the same value as seen in the upper cell.

1 g 1 : 4 g 2 : 2 g 3. However, they did not bear any protocorm.

Spatial structures of populations

A locus of *S. japonicus* was spread along a big crack on the trunk faced to the east on the host-tree architecture of *P. thunbergii*（Table 3）.

The tree of *P. thunbergii* hosting *S. japonicus* had a total of 21 boughs, of which nine lower boughs concentrated individual plants of *S. japonicus* ; more than 60% of the population at the first level, 30–50 cm above the ground ; ca 20% at the second level, 50–180 cm above the ground ; ca 15% at the third level, 200–300 cm above the ground（Table 3）. Some individual plants stood alone and a few loci isolated were found on the boughs at the 4th level, 370 cm above the ground. The uppermost boughs of the tree did not have any plants of *S. japonicus*. The largest loci of *S. japonicus* were situated on the host boughs spreading to the north and south-west directions, while only a few small loci were located on the boughs of south direction（Table 3）.

Interactions of roots of *Sarcochilus japonicus* and epiphytic lichens and mosses

Young roots 1–2 years old on plants of *S. japonicus* were green in color and contained unindentified, unicellular, green algae in cells of the velamen. In contrast, roots 3–4 years old contained mycorrhizal fungi with heavy level of infection. Mycorrhizal infection-intensity of ca 60% in the root cortex cells was not fluctuated during the course of investigation.

Plants of *S. japonicus* were interacted with four of eight epiphytic lichens on the host tree（Table 1）. Rhizoid-like hairs of thalli of *Rimelia reticulata* occurred on roots of *S. japonicus* at the places where the orchid and lichen closely made contact with each other. Those hairs obligatory penetrated into *S. japonicus* roots. On the other hand, the thalli of *R. reticulata*, *Punctelia rudecta* and *Myelochroa aurulenta* often
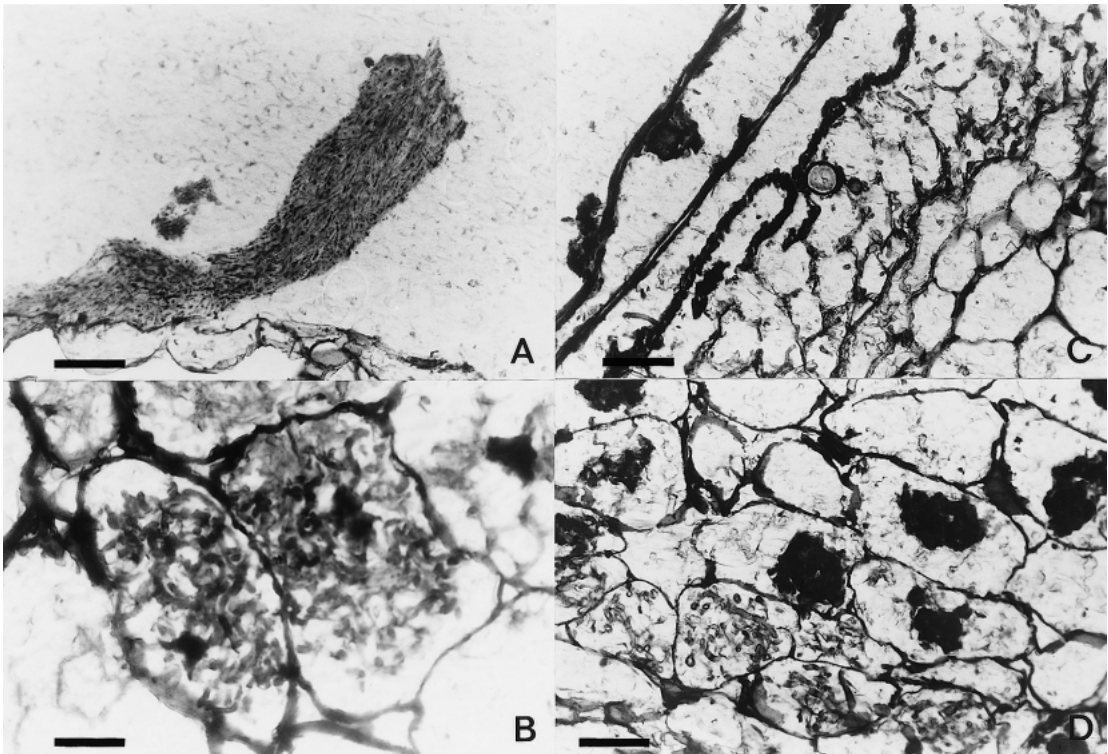

Fig. 3. Relationships of *Sarcochilus japonicus* with lichen（A and B）and moss（C and D）. A, Lichen thallus on the surface of an orchid root. Bar=10 μm ; B, Fungal pelotones in cells of the orchid root with growth association of lichen. Bar=2.2 μm ; C, Moss rhizoids on the surface of an orchid root. Bar=10 μm ; D, Fungal pelotones inside the orchid root with growth assosiation of moss. Bar=5 μm.

grew directly on and covered the surface of *S. japonicus* roots（Fig. 3 A）.

Plants of *S. japonicus* were involved with two and sometimes three or more（total five）out of seven bryophyte species (Table 1) tightly surrounding large areas on the orchid root surface on the host tree（Fig. 3 C）.

Numerous hyphae of fungi were observed between moss stems and rhizoids. Those fungi might form mycorrhiza in roots of *S. japonicus*. The fungi inside the roots of *S. japonicus* which were connected with lichens were different in hyphae morphology from those connected with mosses（Fig. 3 B and D）.

Discussion

Numerous seeds of *S. japonicus* germinated and began to form protocorms within a few months soon after they were dispersed in the field. Duration of this period was shorter than 13 weeks in symbiotic culture and 50 weeks in asymbiotic culture in Australian *Sarcochilus* (Markovina and McGee 2000). The protocorms of the species along the attached host area on the tree bark were characterized as elliptical wing-like in shape. The protocorms developed shortly to the "j" or "im" stage. They eventually formed the monopodial shoot nodes, internodes, a leaf, 1–2 lateral buds and a root. Each internode was covered by a short sheath of green leaf which stayed even after the leaf died and protected the lateral buds. The juvenile or immature plant produced and developed only an axillary bud but never produced any lateral shoot. Vegetatively mature and generative plants produced two serial buds in the axil of every leaf, which would stay and weakly develope during the first 2–4 years and then proliferate to the flower stalks simultaneously or at intervals of 2–3 years. One of the buds sometimes was resting for several years and then, produced lateral, vegetative shoot even on senile plants. Growth of lateral buds was only the way of vegetative reproduction in *S. japonicus*.

The shoot apex of *S. japonicus* always had a growing leaf and a primordium for the next leaf. During the vegetable season a generative plant produced 2–3 leaves. The leaf life lasted approximately three years. Counting number of inter-nodes as well as number of roots and annual root increments in adult plants the life span of adult shoot in the species was estimated to be eight years or more. Furthermore, total individual-plant life was evaluated to last about 15 years.

Roots of *S. japonicus* held the plant body in position on the host tree branch, mycorrhiza formation, and nourishment and water absorption. The roots had velamen of three outer layers. Every new root grew nearly a year after appropriate internode elongation. Root life lasted 3–4 years. The dead roots stayed and would not be decomposed for a long time. New roots and protocorms seemed to use some of those dead roots as substrate for their growth.

The population of *S. japonicus* could be maintained primarily by the sexual reproduction and supplementary by the vegetative reproduction. The flowering period of the species occurred synchronously only once a year for the past four years（Miyama personal communication）. They had annual fluctuation of flower numbers that was a well-known phenomenon and widespread feature in the terrestrial orchids (e.g., Tamm 1972; Wells 1981; Hutchings 1987; Willems 1989). However, what factor caused the annual fluctuation of flower numbers has not been detected yet.

The individual plants separated from the main loci of plants were the representatives of the plants at virginile or young generative stage. A few isolated protocorms were observed at a long distance from the main loci. Some loci were composed of 1–2 generative plants and 1–3 protocorms or juvenile plants. This observation suggested that the progress of new locus development and the densely populated area would not be stable but shifted successively. A plant formed from a seed dispersed to new place grew up alone until it reached up to the generative stage and set seeds which would be mostly dispersed and settled protocorms around it. This process would be the establishment course of another new, young locus which had various plants with different age structures. Well-developed loci were characterized by similar age spectra as the whole population. Numbers of plants of the species on the small trees of *P. thunbergii* seemed

not to be able to increase rapidly due to dry conditions of the tree barks.

Age structure of the *S. japonicus* population was similar to that of some terrestrial orchid species which were characterized by the predominant generative germination. For instance, the terrestrial *Liparis japonica* (Miq.) Maxim. and *Malaxis monophyllos* (L.) Sw. had the age spectra with the first highest peak at the stage of protocorms, and the second highest peak at the stages of juvenile and generative age (Tatarenko 1996). However, population structures of other terrestrial orchid species could mostly not be measured because many of their protocorms grown in or on the ground were too small to be detected from sights.

Spatial structures of epiphytic orchid populations seemed to be strongly depended on the host tree architecture of *P. thunbergii*. The host trunk of *P. thunbergii* studied was covered with barks 5–8 mm thick, which contained certain amount of humus and water. Vitality of the protocorms and juvenile plants grown on the trunk was surprisingly low.

Gradual decrease of individual numbers of *S. japonicus* from the bottom to the top of the host tree would be correlated with environmental factors especially microclimates such as relative humidity, light intensity and wind velocity and direction. Plant-attaching positions of *S. japonicus* could be depended on spreading direction of boughs of the host tree of *P. thunbergii*.

Another interesting spatial-structure in the habitat of *S. japonicus* was dependence of plant distributions and sizes of boughs on the pine trunk. On the boughs 12–25 cm diameter the orchid loci always appeared along the boughs on their shade side. Roots of *S. japonica* plants in these loci grew mostly linearly along the branch and covered or occupied 45–90% surface of the host bough. On the narrow twigs 1.5–3.0 cm diameter the orchid loci had a common "locus space" due to many roots densely covered the twigs and extended across neighbor twigs at same height level as well as neighbor boughs at different hight level. Holophytic structure created disjunctive space for population growth. However, the tendency to continuous distribution of plants was apparently observed especially in old loci of the species.

Another interesting phenomenon on the spatial structure of the population in *S. japonicus* was formation of shoot-root hanging bundles as locus. The old bundles 4–5 cm diameter consisted of 5–13 generative plants. Seeds of the species often attached to the surface of these bundles and developed young plants which increased numbers of shoots.

Areas of roots of the plants in *S. japonicus* spread on the surface of attached substratum on the host bough or twig were several times as large as the areas occupied by hanging shoots. Root substrata of plants of the species were very favorable for seed germination since they carried, transplanted and infected active mycorrhizal fungi from relative-plant roots to seeds for embryo development and germination. The majority of their protocorms was found in spaces between roots on either bough or twig of the host tree. In case of the populations of some terrestrial orchid -species previously reported, their seeds predominantly germinated if they were placed closely near by roots of their mother plants where mycorrhizal fungi could be easily introduced (Nikitina and Denisova 1980; Tatarenko 1991; Batalov 1998). Thus, the population structure of *S. japonicus* was quite similar to that of the terrestrial orchid-species studied (Nikitina and Denisova 1980; Tatarenko 1991; Batalov 1998).

Sarcochilus japonicus could be associated with unidentified, unicellular green algae in cells of the velamen and cortex in young roots, mycorrhizal fungi in roots 3–4 years old at the mycorrhizal infection-intensity of ca 60% in the root cells studied, four epiphytic lichens, and two or sometimes three more (total five) bryophyte species. According to During and Van Tooren (1990), some bryophytes were involved in a variety of competitive, parasitic, symbiotic, mutualistic and as yet unspecifiable interactions with vascular plants, algae, fungi, lichens, cyanobacteria and autotrophic and heterotrophic bacteria. Additional anatomical observations in roots of *S. japonicus* could be expected to improve our concept of the interactions between *S. japonicus* and its associates.

Acknowledgements

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イリナ　V. タタレンコ[1]・近藤勝彦[2]：日本産ラン科カヤランの個体群に関する研究

　広島県福富町長圓寺のクロマツ古木に着生するカヤランの個体群について分析した。種子は発芽するとプロトコームを形成した。初期のプロトコームは細長く伸び，樹皮表面に這うように翼状に定着し，先端には微小の鱗片葉を 1 枚着け，生長とともに第一本葉と根をだした。1〜2 枚の本葉と根を 1.5 cm ほどに伸ばした幼植物体が形成された最終段階で，プロトコーム本体は枯れた。個体群の維持，生長は有性生殖によるが，一部単軸シュートにでた側芽の生長による栄養繁殖によった。個体群内の相対的年齢構成比率は，すでに報告した地生ラン数種個体群での年齢構成に似ていた。クロマツ樹上のカヤラン密生部位は北〜南西面に広がった枝上にあった。

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