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Three Newly Recorded Species of the Genera *Acaphylla* Keifer and *Calacarus* Keifer (Prostigmata: Eriophyidae) from *Camellia* spp. (Theaceae) in Korea

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동백나무류에서 발생하는 국내 미기록 혹응애류 3종에 대한 보고

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ABSTRACT: Three species belonging to genera *Acaphylla* Keifer and *Calacarus* Keifer (Prostigmata: Eriophyidae) that cause damage to *Camellia* (Theaceae) plants, have been newly recorded in Korea. The three species, *Acaphylla theae* (Watt), *Acaphylla theavagrans* Kadono, and *Calacarus carinatus* (Green), have been redescribed and illustrated. Keys to Korean species of the genus *Acaphylla*; their distribution; and biological information, such as host plants and damage symptoms, are also presented.

Key words: *Acaphylla*, *Calacarus*, *Camellia* spp., newly recorded species, key, Eriophyidae, Korea

초 록: 한국산 동백나무류에서 서식하는 3종의 국내 미기록 혹응애(전기문목: 혹응애과), *Acaphylla theae* (Watt), *A. theavagrans* Kadono 및 *Calacarus carinatus* (Green)에 대한 분류학적 설명과 주요형질의 삽화를 제공하고, 기주식물과 피해양상 등의 생물학적 정보 또한 제공한다.

검색어: 쐐기혹응애속, 민등혹응애속, 동백나무류, 미기록 종, 검색표, 혹응애과, 한국

Eriophyid mites are highly specific parasites of plants, potentially attacking all plant parts other than the roots (Westphal and Manson, 1996). Although they are obligatory plant-feeding mites, they are poorly understood and often overlooked because of their extremely small size (average body length, 200 μm) and cryptic habits (Manson, 1984).

A total of 18 species in 8 genera of Eriophyidae have been reported in Korea (Anonymous, 1928; Kim, 1965; Huang, 1972; Anonymous, 1973; Anonymous, 1986; Baker et al., 1986; Kim, 1990; Choi et al., 1992; Park et al., 1996; Na et al., 1998; Lee et al., 1999). Although 5 eriophyid species have been obtained from *Camellia* spp. globally (Amrine and Stasny, 1994; Channabasavanna, 1996), there have been no records of them in Korea. After a long-term survey of eriophyid fauna in Korea, we, herein, report new occurrences of three species on *Camellia* spp. in Korea: *Acaphylla theae* (Watt), *A. theavagrans* Kadono, and *Calacarus carinatus* (Green).

Plant samples were collected and examined for the presence of mites by using a field microscope (Field Microscope Mini; Nikon, Japan) and a stereomicroscope (SteREO Discovery. V12; Carl Zeiss, Germany). They were mounted on slides, according to Keifer's methodology (Keifer, 1952; Kadono, 1995). The classification and terminology of Amrine et al. (2003), and Amrine and Manson (1996) were used. Measurements

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were undertaken according to Amrine and Manson (1996) and de Lillo et al. (2010), and given in micrometers.

Systematic Accounts

Tribe Acaricalini Amrine and Stasny, 1994

Acaricalini Amrine and Stasny, 1994, Catalog Eriophyoidea: 767.

Type Genus: *Acaricalus* Keifer, 1940b, ES X, BCDA 29(3): 214.

DIAGNOSIS. Scapular setae (*sc*) absent or present and their tubercles set well ahead or near rear margin of shield, orienting setae in variable directions. Opisthosomal annuli evenly down curved laterally or individually extended laterally into blunt lobes. Tarsal empodia of legs I and II with main shaft moderately to deeply divided.

Genus *Acaphylla* Keifer, 1943

"Swae-gi-hog-eung-ae-sok"

Acaphylla Keifer, 1943, ES XIII, BCDA 32: 214.

Type Species: *Acaphylla steinwedeni* Keifer, 1943, ES. XIII, BCDA 32: 215.

DIAGNOSIS. Body robust fusiform; opisthosoma strong differentiated into dorsal and ventral annuli, ventral annuli slightly more numerous; middorsal ridge present; Gnathosoma moderate length. Palp genual seta *d* bifurcate. Scapular tubercles ahead of rear shield margin; *sc* directed upwards, anteriorly, or medially. Legs with normal setation except leg II genual seta (*l″*) lacking; tarsal empodia divided. Coxae I *1b* absent. Opisthosoma with all setae. Female genitalia with internal apodeme of normal length.

Key to species of the genus *Acaphylla* in Korea

1. Prodorsal shield without transverse lines at the center of admedian lines; scapulartubercles present, but tiny, *sc* small, directed medially ····· ***A. theae* (Watt)**
- Prodorsal shield with transverse lines at the center of admedian lines; scapular tubercles nearly vestigial, *sc* very small, directed medially ····· ***A. theavagrans* Kadono**

1. *Acaphylla theae* (Watt, 1898) (Fig. 1 and 4)

"Dong-baek-hog-eung-ae"

Phytoptus theae Watt, 1898, Office, Supt. Govt. Printing, Calcutta, India 1898: 400-408 (TL: India; TH:.*Camellia sinensis* (L) Kuntze.).

Acaphylla steinwedeni Keifer. 1943, ES XIII, BCDA 32: 215 (synonymized by Das and Sengupta, 1958, J. Zool. Soc. India 10: 39-48).

Acaphylla theae: Keifer, 1954, ES XXII, BCDA 43: 126.

DIAGNOSIS. This species differs from others by the prodorsal shield with a slightly indented frontal lobe, frontal lobe in lateral view with a ventral knob, and the lack of transverse line at the center of admedian lines.

FEMALE. Body fusiform, blunt anteriorly, orange, 170-194 long, 70-75 wide. Gnathosoma 30 long, dorsal pedipalp genual setae 14-19 long, abruptly bent and bifurcate. Prodorsal shield 62-68 long, 75-78 wide; with centro-longitudinal ridge made by segmented median line and admedian lines; frontal lobe indented, projecting over gnathosoma; design of relatively few longitudinal and transverse lines and with lateral granules; scapular tubercles well ahead of rear margin; scapular setae *sc*

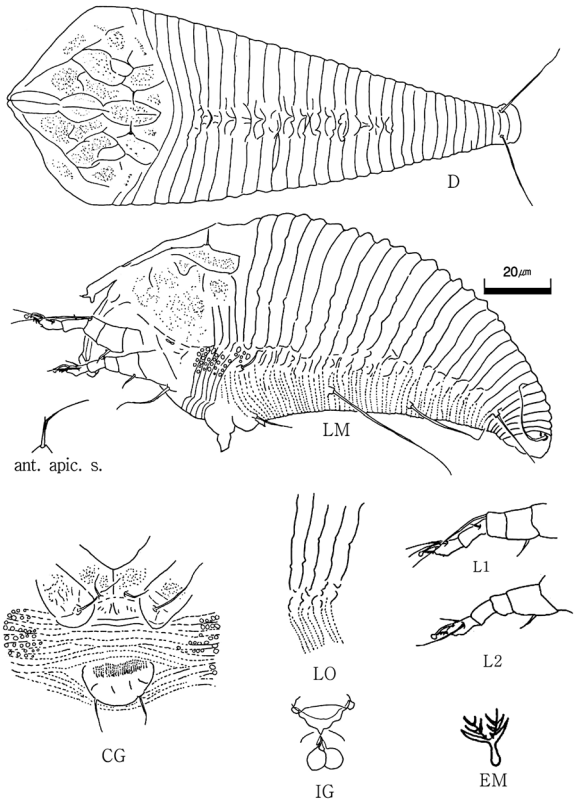

Fig. 1. *Acaphylla theae* (Watt). (CG: coxigenital region; D: dorsal view; EM: empodium; IG: female internal genitalia; LM: lateral view; LO: lateral opisthosoma, L1: leg I; L2: leg II; ant. apic. s: dorsal pedipalp genual setae (*d*)).

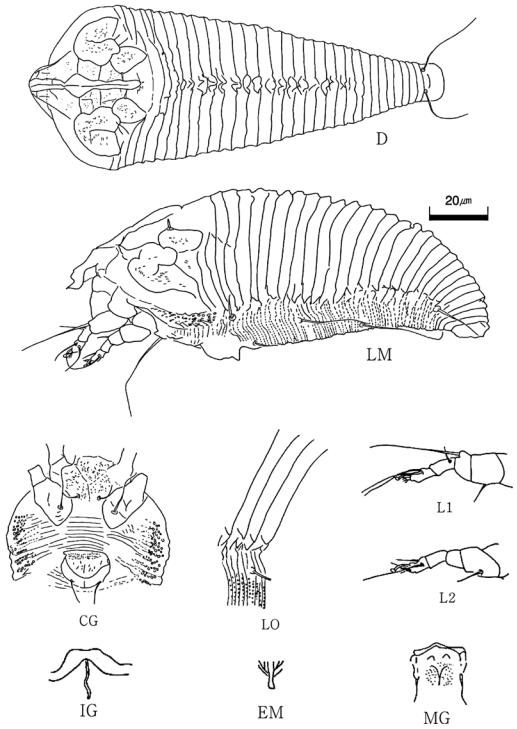

Fig. 2. *Acaphylla theavagrans* Kadono. (CG: coxigenital region; D: dorsal view; EM: empodium; IG: female internal genitalia; LM: lateral view; LO: lateral opisthosoma, L1: leg I; L2: leg II).

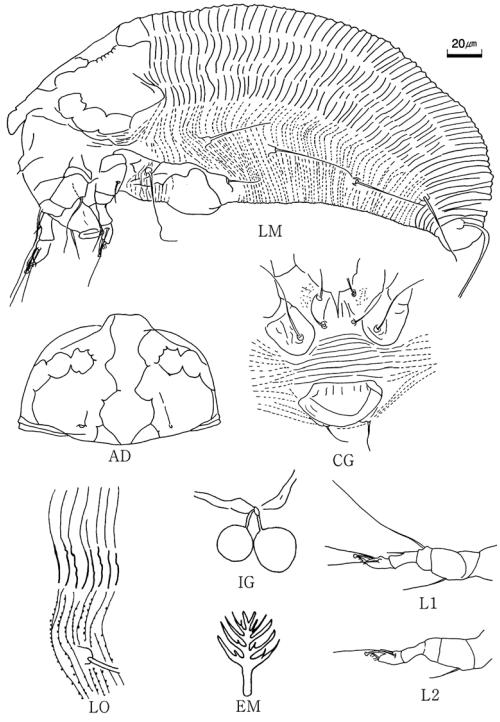

Fig. 3. *Calacarus carinatus* (Green). (AD: anteriodorsal view; CG: coxigenital region; EM: empodium; IG: female internal genitalia; LM: lateral view; LO: lateral opisthosoma, L1: leg I; L2: leg II).

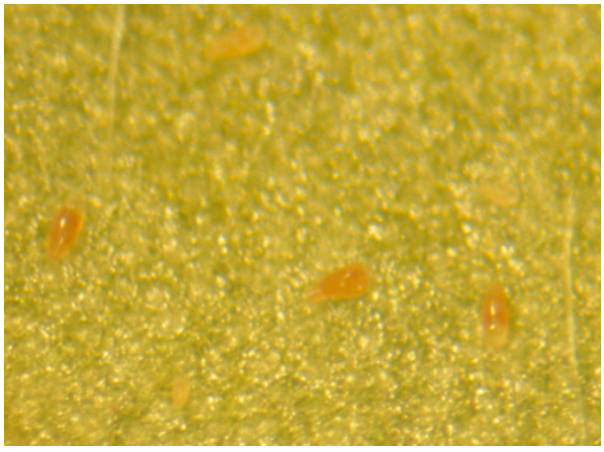

Fig. 4. *Acaphylla theae* (Watt); female and immature mites on lower leaf surface of *Camellia japonica*.

5 long, directed centrad and upward. Opisthosoma with middorsal ridge; dorsal annuli 29-30 without microtubercles; ventral annuli 68-70, microtubercles small, beadlike, touching rear annular margins. Setae *h1* absent; tubercles tiny, but vestigial. Coverflap with numerous broken longitudinal lines and granules basally and 4-5 irregular longitudinal lines apically; coxae III setae *3a* 10-12 long. Coxae I and II with granules; sternal line present; coxae I seta *1b* absent. Leg II antaxial genual seta *l''* absent; empodia divided, 3-rayed; tarsal solenidia knobbed.

MALE. Present, smaller than female, about 150 long, 55 wide, with bilobed frontal lobe more apparent.

MATERIALS EXAMINED. 21♀, 3♂ (Coll.#010422-2), Seonunsa Temple, Gochang, JeollaBuk-do, 22.iv.2001, Jong-Ho Lee, on *Camellia japonica* L.

HOST PLANTS. *Camellia japonica* L., *C. sasanqua* Thumb. (Theaceae)

DAMAGE SYMPTOM. Mites are vagrant on lower leaf surface and live under floral bud scales; sometimes causing leaf rust.

DISTRIBUTION. Korea (JeollaBuk-do); China, Japan, India, Malaysia, Taiwan; Italy, USA (Channabasavanna, 1996; Hong & Zhang, 1996; Kadono, 1992; Keifer, 1943).

2. *Acaphylla theavagrans* Kadono, 1992 (Fig. 2 and 5)

"Cha-hog-eung-ae"

Acaphylla theavagrans Kadono, 1992, Acta Arachnol. 41(2):

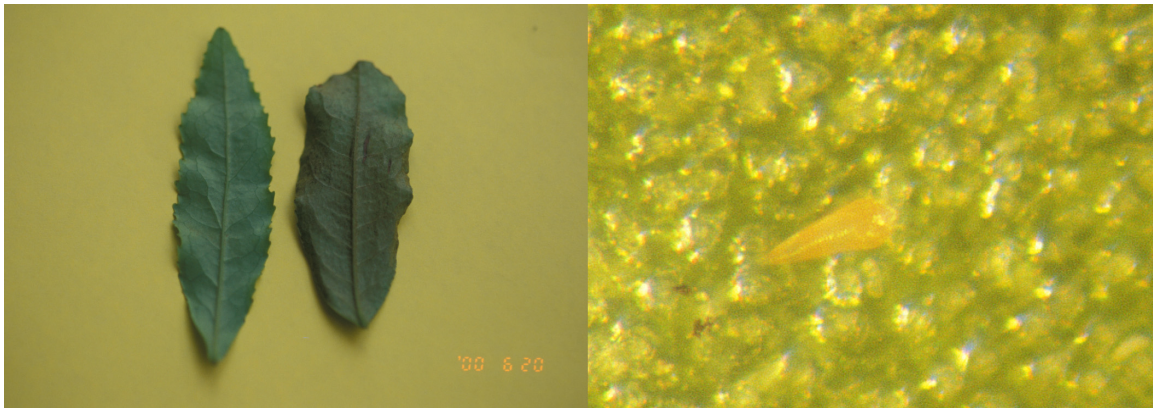

Fig. 5. *Acaphylla theavagrans* Kadono. Damage symptom (health leaf (left) and infested leaf (right)) and female mite on lower leaf surface of *Camellia sinensis*.

149 (TL: Hyogo Pref., Japan; TH: *Camellia sinensis* (L.) Kuntze).

DIAGNOSIS. This species differs from others by the prodorsal shield with indented frontal lobe and by transverse line at the center of admedian lines.

FEMALE. Body fusiform, blunt anteriorly, orange color, 180-210 long, 70-80 wide. Gnathosoma bent down, 30 long; dorsal palp genual setae 14-19 long, abruptly bent, bifurcate. Prodorsal shield subsemicircular, 60-64 long, 70-83 wide; frontal lobe slightly indented, shield design with longitudinal lines and granules; faint, segmented median line and complete admedian lines forming pen-point shaped central longitudinal figure; submedian and lateral lines forming network pattern with transverse lines, especially transverse line at the center of admedian line apparent; scapular tubercles well ahead of rear margin, but vestigial; scapular setae *sc* 4 long, directed centrad and upward. Opisthosoma with middorsal ridge; dorsal annuli 29-33 without microtubercles; ventral annuli 69-74; microtubercles small, beadlike, touching rear annular margins. Setae *h1* absent, tubercles vestigial. Coverflap with numerous broken longitudinal lines and granules basally and 5-7 irregular longitudinal lines apically; coxae III setae *3a* 10-12 long. Coxae I with granules, coxae II smooth; sternal line present, faint. Empodia divided, 3-rayed; tarsal solenidia knobbed.

MALE. Present, smaller than female, about 160 long, 60 wide.

MATERIALS EXAMINED. 15♀, 1♂ (Coll.#000615-2), Ssanggye Temple, Hadong, GyeongsangNam-do , 15.vi.2000, Jong-Ho Lee, on *Camellia sinensis* (L.) Kuntze ; 6♀ (Coll. #050609-1), Boseong, JeollaNam-do, 9.vi.2005, Jong-Ho Lee, on *C. sinensis* (L.) Kuntze ; 2♀ (Coll. .#090710-2), Seonheul, Jocheon, Jeju, Jeju-do, 10.vii.2009, Jeong-Hup Song, on *Camellia sinensis* (L.) Kuntze.

HOST PLANT. *Camellia sinensis* (L.) (Theaceae).

DAMAGE SYMPTOM. Vagrant on lower leaf surface and causing leaf rust (Fig. 4).

DISTRIBUTION. Korea (GyeongsangNam-do, JeollaNam-do, Jeju-do); Japan, Taiwan (Channabasavanna, 1996; Kadono, 1992).

REMARKS. This species was first reported from Japan as a new species, because the transverse line at the center of admedian lines of prodorsal shield differs from the very similar species, *A. theae* (Watt) (Kadono, 1992). Additionally the scapular setal tubercles of *A. theavagrans* Kadono is vestigial, while those of *A. theae* (Watt) is tiny not vestigial.

Tribe Calacarini Amrine and Stasny, 1994

Calacarini Amrine and Stasny, 1994, Catalog Eriophyoidea: 768.

Type Genus: *Calacarus* Keifer, 1940b, ES X, BCDA 29: 163.

DIAGNOSIS. Scapular setae (*sc*) vestigial or absent. Opisthosomal annuli evenly down curved laterally or individually extended laterally into blunt lobes. Tarsal empodium of legs I and II with main shaft entire.

Genus *Calacarus* Keifer, 1940

"Min-deung-hog- eung-ae-sok"

Calacarus Keifer, 1940b, ES X, BCDA 29: 163.

Type Species: *Calacarus pulviferus* Keifer, 1940b, ES X,

BCDA 29: 163-164.

DIAGNOSIS. Body robust fusiform; opisthosoma strong differentiation into dorsoventrally, ventral annuli slightly more numerous; opisthosoma with at least a longitudinal ridge and two longitudinal subdorsal ridges present. Gnathosoma long, abruptly bent down. Prodorsal shield usually with tubercles, but setae minute or absent. Legs with normal setation except leg II antaxial genual setae (*l″*) lacking; tarsal empodia simple. Coxae with normal setation. Opisthosoma with all setae. Female genitalia with internal apodeme of normal length.

3. *Calacarus carinatus* (Green, 1890) (Fig. 3 and 6)

"Cha-geom-eun-hog-eung-ae"

Typhlodromus carinatus Green, 1890, Insect Pests of the tea plant: 35 (TL: Colombo, Sri Lanka; TH: *Camellia sinensis* (L.) Kuntze).

Eriophyes carinatus: Nalepa, 1923, Marcellia 29(1-3): 25-66.

Calacarus carinatus: Keifer, 1955, Pan-Pacific Entomol. 31(3): 115.

Epitrimerus adornatus Keifer, 1940a, ES VIII, BCDA 29: 32.

DIAGNOSIS. This species differs from others by the purple body color, 5 longitudinal wax bearing ridges on opisthosoma, cellular pattern of prodorsal shield without scapular setae, and absence of the leg II genual setae (*l″*).

FEMALE. Body robust fusiform, dull deep-purple, shield lines and dorsal ridges with white wax, 190-240 long, 79-93 wide. Gnathosoma 55 long, large and curved down. Prodorsal shield design forming a cellular pattern, 50-63 long, 71-85 wide; with round frontal lobe; scapular tubercles apparently present, scapular setae absent. Dorsal annuli 52-68; with five dorsal longitudinal ridges, smooth. Ventral annuli 69-79; microtubercles small, beadlike, on rear annular margins. Setae *h1* absent. Coverflap smooth with 11 short faint lines; coxae III setae *3a* 13-16 long. Coxae smooth, Empodia 5-rayed; tarsal solenidia strongly knobbed.

MALE. Not observed; male is known in Japan, which is smaller than female (Kadono, 1995).

MATERIALS EXAMINED. 8♀ (Coll.#010512-1), Wonnam, Gangjin, JeollaNam-do, 12.v.2001, Jeong-Woo Seo, on *Camellia sinensis* (L.) Kuntze; 4♀ (Coll.#090515-2), Dongyoul, Whoecheon, Boseong, JeollaNam-do, 15.v.2009, Jong-Ho Lee, on *Camellia sinensis* (L.) Kuntze; 2♀ (Coll.#090710-1), Sanggui, Eweol, Jeju, Jeju-do, 10.vii.2009, Jeong-Hup Song, on *Camellia sinensis* (L.) Kuntze.

Fig. 6. *Calacarus carinatus* (Green). Female mites on lower leaf surface of *Camellia sinensis*.

HOST PLANTS. *Camellia sinensis* (L.) (Theaceae), *C. caudata* (Wallich); *C. japonica* L.; *C. kissi* (Wallich); *Capsicum annuum* L.; *Viburnum opulus* L. (Caprifoliaceae).

DAMAGE SYMPTOM. Vagrant on lower leaf surface. It may cause bronzing and leaving white cast skin streaks on both leaf surfaces.

DISTRIBUTION. Korea (JeollaNam-do, Jeju-do); Cambodia, China, Japan, India, Indonesia, Laos, Malaysia, Sri Lanka, Taiwan, Vietnam; Italy, Portugal, Spain, USSR; USA; Australia, New Zealand (Channabasavanna, 1996; Hong & Zhang, 1996; Manson, 1984).

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