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Description of *Philodromus rufus* Walckenaer, 1826 with a new synonym (Araneae: Philodromidae) from Korea

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Contribution to Environmental Biology

- Spiders are important arthropods that contribute to biodiversity in the terrestrial ecosystem.
- The description of this species with the proposition of a new synonym provides important information for understanding Korean spider fauna.

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Abstract: The present study describes *Philodromus rufus* Walckenaer, 1826 with detailed descriptions, taxonomic photographs, distribution map, and proposition of a new synonym. Due to morphological similarity between *P. pseudoexilis* Paik, 1979 and *P. rufus*, taxonomic identity of *P. pseudoexilis* has been doubtful to date. A detailed bibliographic study of types of *P. pseudoexilis* between *P. rufus* and examination of specimens from the type locality of *P. pseudoexilis* with specimens of *P. rufus* collected across the country showed that *P. rufus* has all diagnostic characters found in types of *P. pseudoexilis*. Therefore, *P. pseudoexilis* Paik, 1979 should be regarded as a new synonym of *Philodromus rufus* Walckenaer, 1826.

Keywords: description, morphology, synonym, taxonomy, Korea

1. INTRODUCTION

Philodromidae Thorell, 1869 is one of the most diversified families with 29 genera. The genus *Philodromus* Walckenaer, 1826 contains 216 species, of which ten species occur in Korea (Yoo *et al.* 2015; Jang *et al.* 2024; World Spider Catalog 2024). Among them, *Philodromus rufus* Walckenaer, 1826 is a running crab spider frequently found in bush layers in marshes, mountains, and arable lands (Kim *et al.* 2016) throughout the Korean Peninsula (Paik 1979a; Namkung 1980, 1985; Im 1984, 1992, 1994; Kim 1985; Namkung *et al.* 1988, 2002; Im and Kim 1996, 1998; Kim and Yoo 1996; Lee *et al.* 2000; Kim *et al.* 2011, 2012; Kwon *et al.* 2013). Paik (1979a) reported that *P. rufus* and *Philodromus* sp. were distributed at Jikjisa Temple in Mt. Hwanghaksan (Gyeongsangbuk-do); in the same year, *Philodromus* sp. was described as a new species, *Philodromus pseudoexilis* Paik, 1979. However, while revising the Korean *Philodromus* in this paper, Paik (1979b) did not describe *P. rufus*, which he had collected from Mt. Hwanghaksan, and designated as a newly recorded species to Korean spider fauna. In addition, *P. pseudoexilis* is morphologically very similar to *P. rufus*; domestic scholars have been doubtful of misidentification. Hence, we investigated almost all the recorded lo-

calities including the type locality of *P. pseudoexilis* intensively and collected sufficient male and female spiders to verify this taxonomic identity of the species. In addition, we compared specimens of *P. rufus* collected across the country. The present study describes *P. rufus* with detailed descriptions, taxonomic photographs, distribution map, and proposes a new synonym.

2. MATERIALS AND METHODS

All specimens were collected by hands, sweep net, and pitfall traps and preserved in 98% ethyl alcohol and external morphology was examined under a Leica S8APO (Singapore) stereomicroscope. Images were captured with a Dhyana 400DC zoom digital camera (China) mounted on a Leica S8APO and assembled using Helicon Focus 8.2.0 image stacking software (Khmelik *et al.* 2006). Measurements of body parts were made with an ocular micrometer and are recorded in millimeters. Internal genitalia of females were removed and treated in 10% KOH for two hours before illustration. Leg measurements are shown as: Total length (femur / patella / tibia / metatarsus / tarsus). Morphological terminology follows Schick (1965), Dondale and Redner (1978), and Muster (2009). The following abbreviations are used in the descriptions: **AER** = anterior eye row, **PER** = posterior eye row in the eye region, **d** = dorsal surface, **v** = ventral surface in leg supination, **CD** = copulatory duct, **CO** = copulatory opening, **EG** = epigynal groove, **FD** = fertilization duct, **GH** = glandular head, **MS** = median septum, **S** = spermatheca in female, **C** = conductor, **E** = embolus, **EB** = embolic base, **RTA** = retrolateral tibial apophysis, **SD** = sperm duct, **T** = tegulum, **VBA** = ventral bulbar apophysis, **VTA** = ventral tibial apophysis in male.

3. TAXONOMIC ACCOUNTS

Family Philodromidae Thorell, 1869
Genus *Philodromus* Walckenaer, 1826
Type species. *Araneus aureolus* Clerck, 1757.

***Philodromus rufus* Walckenaer, 1826**
북방새우게거미 (Figs. 1, 2B, C)

Philodromus rufus Walckenaer, 1826: 91; Walckenaer, 1837: 555; Simon, 1875: 287; Becker, 1882: 229, pl. 25, f. 1; Chyzer & Kulczyński, 1891: 107, pl. 4, f. 16; Bösenberg, 1902: 333, pl. 31, f. 494; Simon, 1932: 854, 884, f. 1299, 1301; Chickering, 1940: 228, f. 74–76; Nakatsudi, 1942: 15, f. 5C; Tullgren, 1944: 117, f. 44, pl. 16, f. 225, pl. 17, f. 226, 227; Kaston, 1948: 434, f. 1585, 1602–1606; Hull, 1950: 426, pl. 3, f. 14; Saitō, 1959: 133, f. 177a–c; Zhu & Wang, 1963: 477, f. 28; Dondale, 1964: 825, f. 1, 2, 5, 7–9; Tystshenko, 1971: 108, f. 240, 249; Miller, 1971: 127, pl. XVII, f. 6, 7; Dondale, 1972: 52, f. 1, 2, 5, 6; Brændegaard, 1972: 22, f. 9; Qiu, 1983: 97, f. 13.8a, b; Hu, 1984: 332, f. 341.1; Zhu & Shi, 1985: 181, f. 163a–c; Yaginuma, 1986: 216, f. 121.3; Song, 1987: 265, f. 220; Urita & Song, 1987: 32, f. 10A–B; Zhang, 1987: 216, f. 188.1, 2; Segers, 1989: 38, f. 1, 2, 7; Izmailova, 1989: 131, f. 123; Chikuni, 1989: 135, f. 10; Chen & Gao, 1990: 165, f. 209a, b; Heimer & Nentwig, 1991: 458, f. 1214; Roberts, 1993: 8, f. 2b, 4d, f; Zhao, 1993: 346, f. 167a, b; Roberts, 1995: 174, f.; Mcheidze, 1997: 128, f. 184; Song & Zhu, 1997: 195, f. 138A, B; Bellmann, 1997: 184, f.; Roberts, 1998: 186, f.; Song, Zhu & Chen, 1999: 476, f. 271L; Hu, 2001: 326, f. 194.1, 2; Song, Zhu & Chen, 2001: 375, f. 246A, B; Kim & Jung, 2001: 200, f. 64, 65; Namkung, 2001: 508, f. 41.6a, b; Namkung, 2003: 511, f. 41.6a, b; Almquist, 2006: 468, f. 400a, d; Ono & Ban, 2009: 479, f. 47–49; Uyar, Kaya & Ugurtas, 2010: 53, f. 9, 10; Benjamin, 2011: 19, f. 62A–G; Zhu & Zhang, 2011: 426, f. 304A, B; Yin *et al.*, 2012: 1248, f. 670a, b; Gómez-Rodríguez & Salazar-Olivo, 2012: 3, f. II.1; Kovblyuk *et al.*, 2016: 80, f. 200–205, 212; Kastrygina & Kovblyuk, 2016: 49, f. 4–6, 9, 10, 13, 14; Kim & Lee, 2017: 76, f. 43A–D, pl. 14; Lecigne *et al.*, 2019: 47, pl. 3H, 4H, 5H; Zarikian, 2021: 498, f. 1C, 2C; Zhang, Peng & Zhang, 2022: 264, f. 196A–G.

Philodromus clarkii Blackwall, 1850: 338.

Artama rufus Simon, 1864: 416.

Philodromus pellax Herman, 1879: 219, 371.

Philodromus clarae Bertkau, 1880: 246, pl. 6, f. 1.

Philodromus pictus Emerton, 1892: 373, pl. 31, f. 2; Emerton, 1902: 37, f. 108–110.

Philodromus exilis Banks, 1892: 63, pl. 2, f. 40.

Philodromus rufus virescens Simon, 1932: 854, 885.

Philodromus pseudoexilis Paik, 1979b: 437, f. 81–89; Kim & Jung, 2001: 199, f. 41–45 (**new synonym**).

Tibellomimus rufus Wunderlich, 2012: 54, f. 44, 45.

Specimens examined. 1♀, Sayo-ri, Cheorwon-eup,

Cheorwon-gun, Gangwon-do, 30 May 2017, leg. S.T. Kim & S.Y. Lee; 2♀♀ 2♂♂, Cheongyang-ri, Gimhwa-eup, Cheorwon-gun, Gangwon-do, 28 May 2021, leg. C.M. Jang & S.T. Kim; 1♀ 4♂♂, Dochang-ri, Gimhwa-eup, Cheorwon-gun, Gangwon-do, 27 May 2021, leg. C.M. Jang & S.T. Kim; 2♂♂, Eupnae-ri, Gimhwa-eup, Cheorwon-gun, Gangwon-do, 28 May 2021, leg. C.M. Jang & S.T. Kim; 3♀♀ 2♂♂, Haksa-ri, Gimhwa-eup, Cheorwon-gun, Gangwon-do, 27 May 2021, leg. C.M. Jang & S.T. Kim; 2♀♀ 1♂, Unjang-ri, Gimhwa-eup, Cheorwon-gun, Gangwon-do, 27 May 2021, leg. C.M. Jang & S.T. Kim; 1♀, Jukjeong-ri, Hyeonnae-myeon, Goseong-gun, Gangwon-do, 23 June 1997, leg. S.T. Kim; 1♀ 1♂, Mt. Bangtaesan, Misan-ri, Sangnam-myeon, Inje-gun, Gangwon-do, 27 May 2010, leg. S.T. Kim & S.Y. Lee; 2♀♀, Mt. Bangtaesan, Misan-ri, Sangnam-myeon, Inje-gun, Gangwon-do, 25 June 2010, leg. S.T. Kim & S.Y. Lee; 1♀ 1♂, Paroho Lake, Guman-ri, Gandong-myeon, Hwacheon-gun, Gangwon-do, 16 April 1997, leg. S.T. Kim; 2♀♀, Paroho Lake, Guman-ri, Gandong-myeon, Hwacheon-gun, Gangwon-do, 07 May 1997, leg. S.T. Kim; 1♀, Gaesu-ri, Daehwa-myeon, Pyeongchang-gun, Gangwon-do, 21 May 1993, leg. S.T. Kim; 1♀ 3♂♂, Geumsa-ri, Namjong-myeon, Gwangju-si, Gyeonggi-do, 22 May 2012, leg. S.T. Kim & S.Y. Lee; 2♀♀, Misa-dong, Hanam-si, Gyeonggi-do, 30 May 1995, leg. S.T. Kim; 1♂, Nohwa-ri, Paltan-myeon, Hwaseong-si, Gyeonggi-do, 20 May 2009, leg. S.T. Kim & S.Y. Lee; 1♀, Yangsu-ri, Yangseo-myeon, Yangpyeong-gun, Gyeonggi-do, 28 May 1993, leg. S.T. Kim; 1♀ 1♂, Deoksan-ri, Sinseo-myeon, Yeoncheon-gun, Gyeonggi-do, 30 May 2017, leg. S.T. Kim & S.Y. Lee; 2♀♀, Magori-ri, Jung-myeon, Yeoncheon-gun, Gyeonggi-do, 29 May 2017, leg. S.T. Kim & S.Y. Lee; 2♀♀ 1♂, Cheongju-si, Chungcheongbuk-do, Korea, 15 May 1992, leg. S.T. Kim; 2♀♀ 1♂, Jikjisa Temple, Unsu-ri, Daehang-myeon, Gimcheon-si, Gyeongsangbuk-do, 20 June 2021, leg. C.M. Jang & S.T. Kim; 1♀, Tonggumi, Namyang-ri, Seomyeon, Ulleung-gun, Gyeongsangbuk-do, 22 May 2019, leg. S.T. Kim & S.Y. Lee; 2♀♀, Na-ri, Buk-myeon, Ulleung-gun, Gyeongsangbuk-do, 22 May 2019, leg. S.T. Kim & S.Y. Lee; 3♀♀, Mt. Sobaeksan, Samga-ri, Punggi-eup, Yeongju-si, Gyeongsangbuk-do, 22 July 2013, leg. S.T. Kim & S.Y. Lee; 1♀ 1♂, Bongamsa Temple, Nohyung-dong, Jeju-si, Jeju-do, 06 June 2001, leg. S.T. Kim; 2♀♀, Yangjae Citizen's Forest, Yangjae-dong, Seocho-gu, Seoul, 02 June 1997, leg. S.T. Kim; 1♀♀ 3♂♂, Pagyesa Temple, Mt. Palgongsan, Jungdae-dong, Daegu, 22 May 2022, leg. C.M. Jang & S.T. Kim; 2♀♀ 4♂♂, Mt. Choijeongsan, O-ri, Gachang-myeon, Daegu, 20 May 2022, leg. C.M. Jang & S.T. Kim; 2♀♀ 1♂, Mt. Mudeungsan, Unlim-dong, Dong-gu, Gwangju, 03 June 2013, leg. S.T. Kim & S.Y. Lee.

Description. Female. Total length 3.58. Carapace 1.58 long / 1.68 wide. Eyes: AER 0.53, PER 0.75. Chelicera 0.56 long / 0.32 wide. Endite 0.38 long / 0.26 wide. Labium 0.23 long / 0.27 wide. Sternum 0.88 long / 0.90 wide. Legs: I 6.14 (1.84 / 0.75 / 1.50 / 1.31 / 0.74), II 7.25 (2.22 / 0.89 / 1.76 / 1.58 / 0.80), III 5.57 (1.78 / 0.71 / 1.27 / 1.21 / 0.60), IV 5.54 (1.74 / 0.66 / 1.25 / 1.27 / 0.62). Palp 1.83 (0.58 / 0.35 / 0.32 / - / 0.58). Abdomen 2.00 long / 1.82 wide. Epigynum 0.29 wide.

Habitus as in Fig. 1A. Carapace pear-shaped, brown, cephalic region light with heart-shaped pattern posteriorly, thoracic median region light, cervical and radial furrows distinct, longitudinal fovea slightly depressed, longer than wide (Fig. 1A). Eight eyes on shallow eye tubercles in two rows, both eye rows recurved, posterior median eyes almost as long as others (Fig. 1C). Chelicera pale yellowish brown with one promarginal tooth. Endite pale reddish brown, longer than wide. Labium reddish brown with dark spots, longer than wide. Sternum heart-shaped, yellowish brown, convex, covered sparsely with brown recumbent hairs, anterior end slightly depressed, covered densely with brown spots, slightly wider than long, posterior tip truncated and slightly protruded between coxae IV (Fig. 1D). Legs yellowish brown, thick and strongly developed, clothed densely with short black hairs, covered densely with dark brown spots, leg spination: I (femur 0-1-1-1d; tibia 3-2-3d / 2-2-2v; metatarsus 3-2-2d / 2-2-0v), II (femur 0-1-1-1d; tibia 3-2-3d / 2-2-2v; metatarsus 3-2-2d / 2-2-0v), III (femur 0-1-1-1d; tibia 3-2-3d / 2-1-2v; metatarsus 3-2-2d / 2-2-3v), IV (femur 0-1-1-1d; tibia 3-2-3d / 1-2-2v; metatarsus 3-2-2d / 2-2-3v), leg formula II-I-III-IV (Fig. 1A). Abdomen ovoid with blunt and bulged posterior end, pale brown, dorsum with a turbid grayish brown longitudinal cardiac pattern occupying anterior half and two pairs of muscle impressions, ivory paramedially, two pairs of brown patterns and two chevrons present posteriorly (Fig. 1A). Epigynum (Fig. 1E): epigynal plate rectangular; median septum pillar-shaped and flattend, four fifth of the length epigynal plate; epigynal atrium divided into

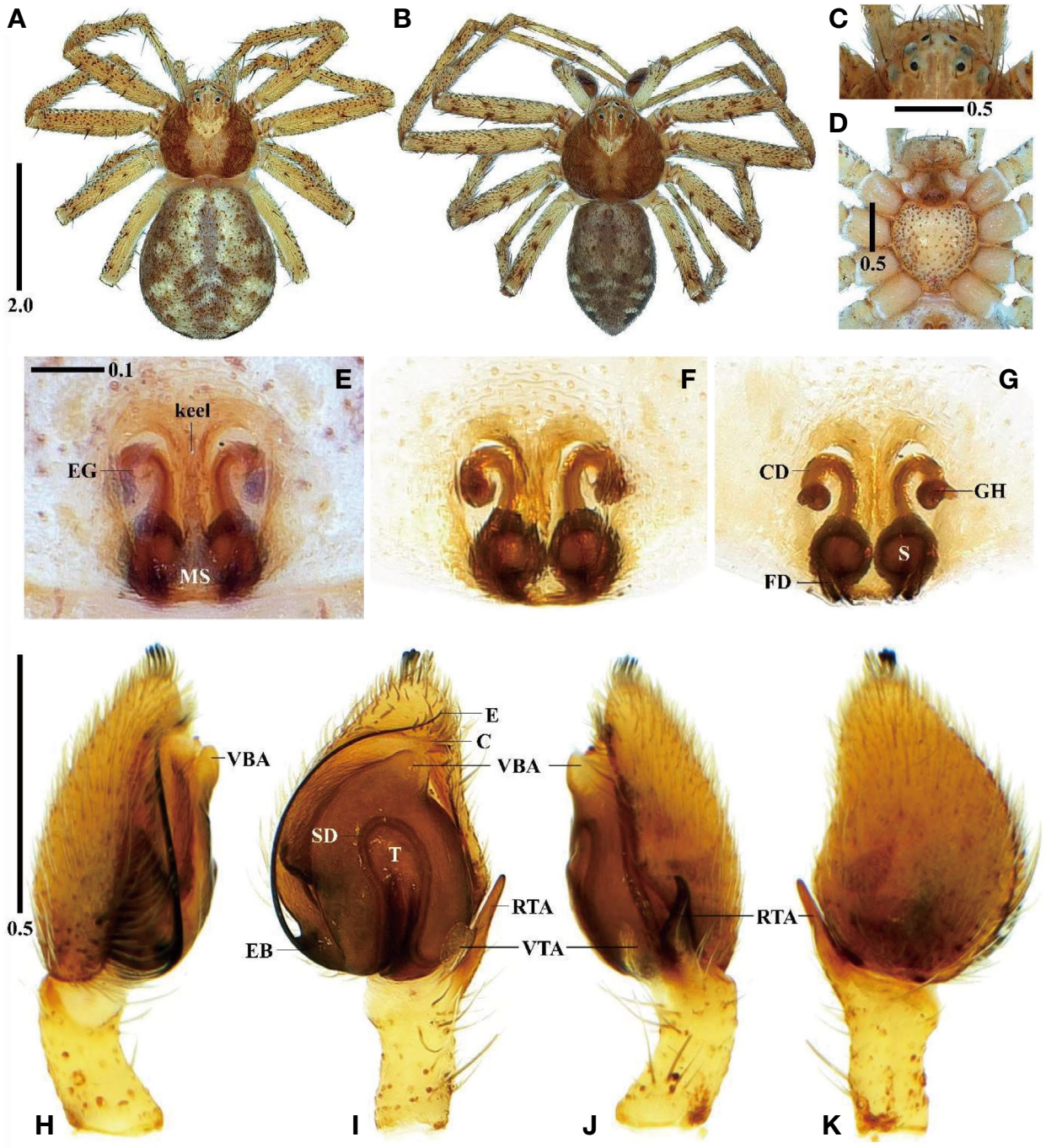

Fig. 1. *Philodromus rufus* Walckenaer, 1826. A, Female habitus, dorsal view; B, Male habitus, dorsal view; C, Female eye area from above; D, Female sternum; E, Female epigynum, ventral view; F, Female internal genitalia, ventral view; G, *Ditto*, dorsal view; H, Male palp, prolateral view; I, *Ditto*, ventral view; J, *Ditto*, retrolateral view; K, Palp, dorsal view. C = conductor, CD = copulatory duct, E = embolus, EB = embolic base, EG = epigynal groove, FD = fertilization duct, GH = glandular head, MS = median septum, RTA = retrolateral tibial apophysis, S = spermatheca, SD = sperm duct, T = tegulum, VBA = ventral bulbar apophysis, VTA = ventral tibial apophysis. Scale bars are in mm.

two epigynal grooves; epigynal groove elongated, large. Internal genitalia (Fig. 1F, G): glandular head distinct and large; glandular mound indistinct; spermatheca small and globular.

Male. Total length 3.37. Carapace 1.50 long / 1.53 wide. Eyes: AER 0.48, PER 0.69. Chelicera 0.47 long /

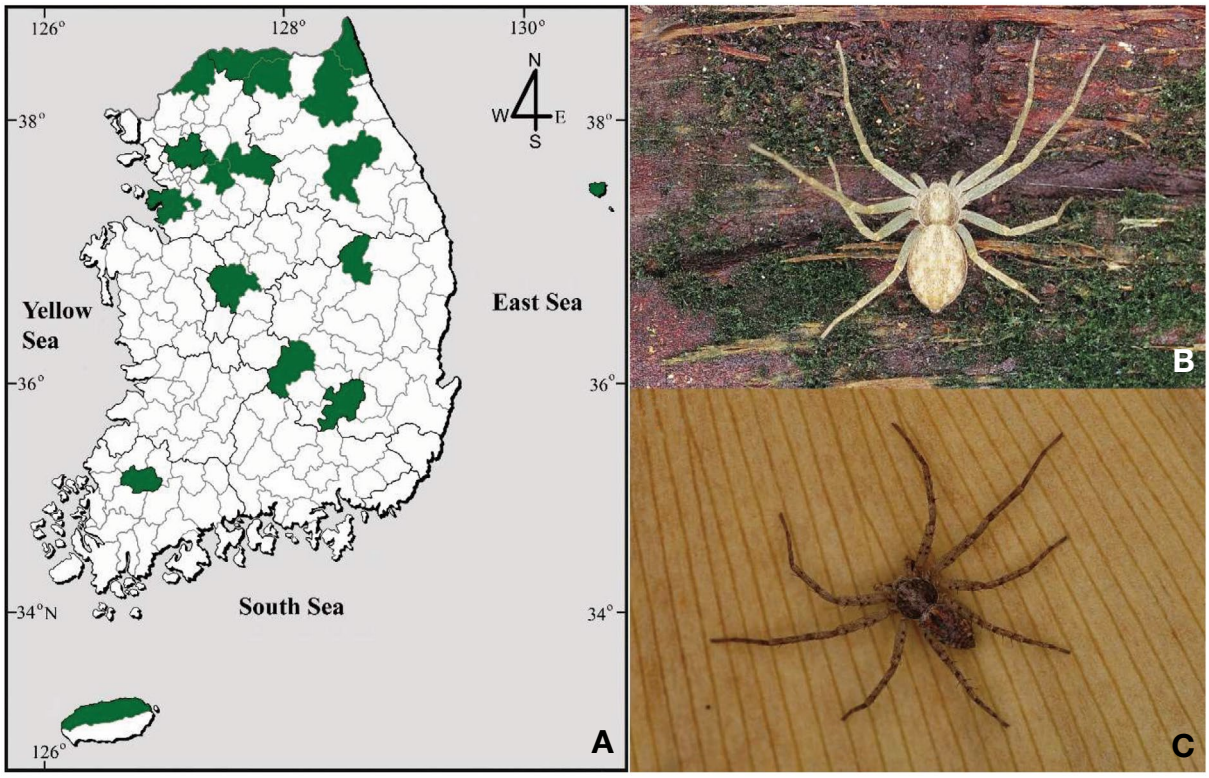

Fig. 2. Distribution map and habitus of *Philodromus rufus* Walckenaer, 1826. A, Distribution of *P. rufus* in Korea; B, Female; C, Male.

0.25 wide. Endite 0.36 long/0.24 wide. Labium 0.21 long/0.23 wide. Sternum 0.89 long/0.90 wide. Legs: I 6.43 (1.82/0.77/1.54/1.44/0.86), II 7.66 (2.14/0.87/1.88/1.73/1.04), III 5.47 (1.66/0.65/1.20/1.27/0.70), IV 5.47 (1.65/0.65/1.20/1.27/0.70). Palp 2.04 (0.74/0.35/0.32/-/0.63). Abdomen 1.87 long/1.33 wide.

General appearance similar to female, habitus as in Fig. 1B. Legs pale blackish brown with brown spots, leg spination: I (femur 0-1-1-1d; tibia 3-2-3d/2-2-2v; metatarsus 3-2-2d/2-2-0v), II (femur 0-1-1-1d; tibia 3-2-3d/2-2-2v; metatarsus 3-2-2d/2-2-3v), III (femur 0-1-1-1d; tibia 3-2-3d/2-1-2v; metatarsus 3-2-2d/2-2-3v), IV (femur 0-1-1-1d; tibia 3-2-3d/1-2-2v; metatarsus 3-2-2d/2-2-3v), leg formula II-I-III≒IV (Fig. 1B). Abdomen ovoid with pointed posterior end, chocolate, dorsum with a dark longitudinal cardiac pattern occupying anterior half and three to four pairs of muscle impressions, four pairs of white spots and one pair of black spots postero-laterally (Fig. 1B). Palp (Fig. 1H–K): cymbium with black apical setae; bulb round; embolus filiform with smooth base; conductor broad; ventral bulbar apophysis distinct; ventral tibial apophysis large, finger-shaped, membranous; retrolateral tibial apophysis large, finger-shaped, sclerotized with pointed tip.

Habitat. Bush layer in marshes, mountains, and arable lands (Kim *et al.* 2016).

Distribution. Korea (Gangwon-do; Cheorwon-gun, Goseong-gun, Inje-gun, Hwacheon-gun, Pyeongchang-gun, Gyeonggi-do; Gwangju-si, Hanam-si, Hwaseong-si, Yangpyeong-gun, Yeoncheon-gun, Chungcheongbuk-do; Cheongju-si, Gyeongsangbuk-do; Gimcheon-si, Ulleung-gun, Jeju-do; Jeju-si, Seoul; Yangjae-dong, Daegu; Jungdae-dong, Gachang-myeon, Gwangju; Unlim-dong (Fig. 2A)), China, Japan, Russia (Europe to Far East), Mongolia, Kazakhstan, Iran, Central Asia, Caucasus, Turkey, Europe, North America.

Comments. As mentioned in introduction, because *P. pseudoexilis* is morphologically very similar to *P. rufus*, the taxonomic identity of *P. pseudoexilis* has been doubtful to date. The detailed bibliographic study of the types of *P. pseudoexilis* between *P. rufus* and examination of specimens from the type locality of *P.*

pseudoexilis with specimens of *P. rufus* collected across the country showed that *P. rufus* has all the diagnostic characters found in types of *P. pseudoexilis* in general appearance, shape of epigynum and internal genitalia structure in females, and the embolic division structure, shape of ventral and retrolateral tibial apophyses of the palpal structure in males. Therefore, *P. pseudoexilis* Paik, 1979 should be regarded as a new synonym of *Philodromus rufus* Walckenaer, 1826.

CRediT authorship contribution statement

CM Jang: Conceptualization, Methodology, Investigation, Collection, Writing-Original draft preparation. **JS Yoo:** Methodology, Writing-Review and editing. **ST Kim:** Conceptualization, Methodology, Investigation, Collection, Identification, Writing-Original draft preparation, Writing-Review and editing, Project administration, Funding acquisition.

Declaration of Competing Interest

No potential conflict of interest relevant to this article was reported.

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