

## A Description with Scanning Electron Microscopy on the Tick *Ixodes persulcatus* (Schulze, 1930) Male and Female Specimens

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### INTRODUCTION

On the occurrence of the ticks belonging to the genus *Ixodes* in Korea, only few reports (Kishida, 1936; Arthur, 1957; Noh, 1965; Han *et al.*, 1966; Kang, 1982 & 1984b) are available. Arthur (1957) reported on the collection of *Ixodes granulatus* from the field mouse *Apodemus agrarius* during the United States Army activities in Korea. In earlier Japanese literature, Kishida (1936) reported on the collection of *Ixodes ricinus* (Linnaeus, 1785) from areas in the northern parts of the Korean Peninsula and *Ixodes coreensis* (Kishida, 1933) from the suburbs of Seoul in the central area of the Peninsula. However, Yamaguti *et al.* (1971) reviewed on the ticks of Japan, Korea and the Ryukyu Islands, and regarded that *I. ricinus* in the earlier Japanese literature was reliably *I. persulcatus* (Schulze, 1930) and that *I. coreensis* was one of the doubtful records reported by earlier Japanese workers.

Noh (1965) collected one unidentified female tick and reported the result of taxonomical study on the specimen with description of *I. persulcatus*. Meanwhile, Han *et al.* (1966) collected a total of 4,431 ticks and reported that most of the specimens consisted of *Haemaphysalis* and *Boophilus* ticks and only one specimen collected in Kyungju was tentatively diagnosed as *I. ricinus* without any detailed informations or

descriptions. It is not clear whether the diagnosis was based on the earlier Japanese literature or on any other doubtful descriptions.

Recently, Kang (1982 & 1984b) collected numerous tick specimens from the host animals and their environments throughout the Korean Peninsula (South) and Cheju Island, and tried to identify them. Among the specimens, lots of *Ixodes* ticks were found and identified as *I. persulcatus*, and it was revealed that the geographical distribution of the tick was confined to the area of eastern parts of the Highland in Daekwanryung, Kangwon Province.

In this report, the scanning electron microphotographs of *I. persulcatus* male and female specimens were presented for an interest in their coitus scene and for understanding of the morphological sexual dimorphism and some surface structures of the capituli and legs, with descriptions.

### MATERIALS AND METHODS

**Tick specimens:** The specimens used in this observation were collected from cattle in a ranch called 'SY' which is located in Hoenggye-ri, Doam-myun, Pyungchang-kun, Kangwon-do (Province) in October, 1982. Among the specimens, a pair of male and female ticks was found in copulation status by chance. They were fixed first in 10% formol-saline for 24 hours and then transferred into 70% ethyl alcohol

containing 10% glycerine for preservation and observation.

**Observation:** The classification and identification of the specimens were done through the observation of their general morphological findings under a light microscope and a stereo microscope. As the authors have been studying the surface fine structures of several kinds of ectoparasites (Kang, 1984a & b; Kang and Byun, 1984; Kang and Jang, 1984), the specimens were also subjected to examination with the scanning electron microscope (Model; SEM ISI-DS-130) manufactured by Korea I.S.I. Co. Ltd. The procedures of pre-treatment, coating, observation and photography were exactly the same as those described in the former presentations. The results obtained were compared with the findings reported by other workers (Small and Marszalek, 1969; Anon. 1974a & b; Stendel and Holm, 1975).

## RESULTS

**Description of the female specimen:** Marked sexual dimorphism is one of the common morphological characteristics of the family Ixodidae, so-called "hard ticks".

As shown in Fig. 1, the female specimen was quite larger than the male specimen. The genital groove was well developed and deep, and the anal groove was distinct and specific, extending anteriorly around the anus. This feature was regarded as a specific morphological characteristic of the genus *Ixodes* in comparison with other genera of ticks (Fillipova and Uspenskaya, 1973; Hoogstraal, 1956; Yamaguti *et al.*, 1971). The female specimen possessed a scutum covering the frontal part of dorsum but without eyes, festoons or any ornamentations. The spiracular plates were present, oval in shape, and situated posteriorly to the coxa IV (Fig. 1). The coxa I possessed a pair of spurs, of which the internal one was very much larger than the external one, pointed sharply, and extending long to overlap some parts of the coxa II (Fig. 3). The articles were well deve-

loped but the last one (4th article) was much reduced and situated on the top of the 3rd article ventrally. The hypostome dentition was 3/3 (Fig. 3). In Figs. 5 and 6, the finger prints were seen on the body surface. The tarsi were a little stout and there were specific setae on the surface of the legs. The pulvilli claws were well developed.

**Description of the male specimen:** As shown in Fig. 1, the male specimen was markedly smaller than the female. There were well developed lateral grooves and numerous punctations on the scutum of the male specimen. It possessed seven shields adhering to and almost entirely covering the ventral surface. The articles were quite broad and bulged widely as shown in Figs. 1 and 4. The coxa I of the male specimen possessed two spurs, short external and long internal ones. The bottom of the basis capitulum was strictly straight in shape, while the cornua was presented as a widely expanded W-shape (Fig. 4). In Fig. 5, the Haller's organ was shown in the leg I. Elizarov (1961) studied on the tick behaviour after amputation of the Haller's organ and eventually confirmed that the ticks without the organ could not react to repellents.

## DISCUSSION

Filimonov (1961) has already studied on the distribution and ecological characteristics of *I. persulcatus* and *I. ricinus*, while Belyayeva (1966) and Belyayeva *et al.* (1966) have studied on the ecology of *I. persulcatus* in the southern Khabarovsk Region, USSR, and reported it developed somewhat more rapidly than ticks of the genus *Haemaphysalis* in the same area. Adults of *I. persulcatus* usually emerged from the end of June to October. The duration of one generation was 288 to 368 days with one diapause and 710 to 720 days with two diapauses. Kitaoka and Fujisaki (1976) have experimented on the blood-concentration rate and relevant physiological properties of the species. Although a useful review (Brocklesby, 1978) on the role of ticks

as vectors and relationship with protozoan diseases is available, a great deal of works has been done by Russian workers for the importance of *I. persulcatus* in disease transmission and pathoecology, such as its relationship with migrating birds (Emel'yanova and Gordeeva, 1969; Galimov *et al.*, 1971), its vector roles for tick-borne encephalitis (Netsky and Ravdonikas, 1961; Netsky *et al.*, 1971; Pchelkina and Zhmaeva, 1966; Rybalko *et al.*, 1963) for Omsk haemorrhagic fever (Netsky and Ravdonikas, 1961), for Q fever (Pchelkina and Zhmaeva, 1966), tularemia (Petrov, 1966) and for rickettsial diseases (Sidorov *et al.*, 1966; Zhmaeva and Pchelkina, 1966). Aleksandrov and Yagodinsky (1966) studied on the possible reasons for virulence changes in an *I. persulcatus* population. In western Siberia the species was regarded as one of the ticks most frequently attacking people (Fedorov, 1968).

### SUMMARY

The surface fine structures of *Ixodes persulcatus* (Schulze, 1930) male and female specimens were observed by means of a scanning electron microscope. A brief review on the biology of the ticks and their disease relationships was also presented.

1. The sexual dimorphism of the specimen was marked; the male was quite smaller than the female.

2. The genital groove was well developed and deep, the anal groove was distinct and characteristically extending anteriorly around the anus.

3. The 4th article was much reduced and situated on the top of the 3rd article ventrally. The hypostome dentition was usually 3/3.

4. The bottom of the basis capitulum of the male specimen was strictly straight in shape.

5. This species was regarded as one of the most important vectors for infectious diseases of migrating birds.

### REFERENCES

- Aleksandrov, Y. V. and Yagodinsky, V.N. (1966) On possible reasons for virulence changes in an *Ixodes persulcatus* population, *Tezisy Dokl. 1. Akarol. Soveshch.*: 14-15 (T 335, NAMRU-3, Cairo).
- Anon. (1974a) Ticks. The extraordinary picture. *Vet. Med. Rev.*, 2: 188-189.
- Anon. (1974b) Ticks. The extraordinary picture. *Vet. Med. Rev.*, 3: 304-305.
- Arthur, D.R. (1957) Studies on exotic ticks (Ixodoidea: Ixodidae) from United States Navy and Army activities. *J. Parasitol.*, 43: 681-694.
- Belyayeva, N.S. (1966) Duration of ixodid tick development in southern Khabarovsk Region. *Tezisy Dokl. 1. Akarol. Soveshch.*: 31 (T 346, NAMRU-3, Cairo).
- Belyayeva, N.S., Kozlovskaya, O.L. and Chernykh, N.A. (1966) On the characteristics of parasitism by ixodid tick larvae and nymphs. *Tezisy Dokl. 1. Akarol. Soveshch.*: 32-33 (T 345, NAMRU-3, Cairo).
- Brocklesby, D.W. (1978) Recent observations on tick-borne protozoa. Tick-borne diseases and their vectors. *Wilde, J.K.H., 1976*: 263-286, Univ. of Edinburgh.
- Elizarov, Y. A. (1961) Physiological properties of chemoreceptors in the tick *Ixodes persulcatus* P. Sch. under the effect of repellents. *Vestn. Mosk. Gos. Univ.*, 16:45-50 (T 570, NAMRU-3, Cairo).
- Emel'yanova, N.D. and Gordeeva, V.P. (1969) Data on the study of birds acting as hosts of ixodid ticks in East Manchurian mountain area spurs and in the Pre-Khanka plain. *Sibirsk. Otd. Akad. Nauk SSSR.*: 160-169 (T 621, NAMRU-3, Cairo).
- Fedorov, V.G. (1968) Ixodoidea ticks on humans in western Siberia. *Med. Parazit. Moskva*, 37:615-616. (T 390, NAMRU-3, Cairo).
- Filimonov, M.N. (1961) Ixodid ticks in the middle Volga regions. *Trydy Il'yanov Sel.-Khoz. Inst.*, 8:59-71 (T 329, NAMRU-3, Cairo).
- Filippova, N.A. and Uspenskaya, I.G. (1973) *Ixodes kaiseri* Arthur, 1957 (Ixodidae) species taxonomic status. *Parazitologiya, Leningrad*, 7:297-306 (T 636, NAMRU-3, Cairo).
- Galimov, V.R., Stolbov, N.M., Ryazantseva, G.P. and Katin, A.A. (1971) Contribution to the question of the role of birds and murine rodents in feeding larvae and nymphs of the taiga tick. *Mater. 6. Simp. Izuch. Virus. Ekol. Svyazan. Ptits.* :77-78 (T 729, NAMRU-3, Cairo).
- Han, T.W., Kim, S.K. and Jeon, Y. (1966) The classification and distribution of Korean cattle tick.

- Res. Rep. Off. Rur. Dev.*, 9:91-103.
- Hoogstraal, H. (1956) African Ixodoidea. *Res. Rep. U.S., NAMRU-3, Cairo*: p.1101.
- Kang, Y.B. (1982) Studies on tick eradication in Korea. *Res. Rep. Special Project Anim. Hlth, Inst. Vet. Res., Off. Rur. Dev., MAF*: p.84.
- Kang, Y.B. (1984a) *Rhipicephalus sanguineus* (Latreille, 1806): A new record of male tick identified with scanning electron microscopy in Korea. *Korean J. Vet. Res.*, 24: 201-212.
- Kang, Y.B. (1984b) Studies on ticks and tick-borne diseases in the Republic of Korea. *Cong. 4th FAVA, Taipei*.
- Kang, Y.B. and Byun, S.Y. (1984) *Cuclotogaster heterographus* and *Anaticola anseris* (Mallophaga: Ischnocera): Collection from *Ciconia boyciana*, description and observation with scanning electron microscopy. *Korean J. Vet. Res.*, 24:227-236.
- Kang, Y.B. and Jang, D.H. (1984) Scanning electron microscopic observations on the surface structures of the tick *Haemaphysalis longicornis* Neuman, 1901. *Korean J. Vet. Res.*, 24:213-226.
- Kishida, K. (1936) Notes on the Acarina-mites and ticks, from the peninsula of Korea and island of Quelpart collected in August 1936. *Lansania*, 8:131-144.
- Kitaoka, S. and Fujisaki, K. (1976) Accumulating process and concentration ratios of ingested blood meals in larvae and nymphs of ten species of ticks. *Nat. Inst. Anim. Hlth. Quart.*, 16:114-121.
- Netsky, G.I., Fedorova, T.N., Bognanov, I.I. and Mal'kov, G.B. (1971) Contribution to comparative ecology of arboviruses of tickborne encephalitis complex in western Siberia. *Tezisy Dokl. Vop. Med. Virus*, 2:140-141 (T 512, NAMRU-3, Cairo).
- Netsky, G.I. and Rabdonikas, D.V. (1961) Results from the 1959~1960 work of the epidemiological detachment for the campaign against tickborne encephalitis, Omsk hemorrhagic fever, tularemia and leptospirosis in Omsk Oblast. *Omsk Nauch. Issled. Inst. Prir. Inf. Min. Zdrav.*, 35-41 (T 755, NAMRU-3, Cairo).
- Noh, Y.T. (1965) A taxonomical study on ticks in Korea (I). The genus *Ixodes*. *Korean J. Zool.*, 8(2):73-76.
- Pchelkina, A.A. and Zhmaeva, Z.M. (1966) Ixodid ticks and mixed natural foci of Q rickettsiosis and tickborne encephalitis. *Tezisy Dokl. 1. Akarol. Soveshch.* 167-168 (T 518, NAMRU-3, Cairo).
- Petrov, V. G. (1966) Ixodid ticks and gamasid mites as vectors of the tularemia infection agent. *Tezisy Dokl. 1. Akarol. Soveshch.*: 155-156 (T 424, NAMRU-3, Cairo).
- Rybalko, S.I., Petrova, E.F. and Prikhod'ko, E.T. (1963) Tickborne encephalitis in eastern Kazakhstan. *Trudy Inst. Zool. Akad. Nauk. Kazakh. USSR.*, 19:234-237 (T 645, NAMRU-3, Cairo).
- Sidorov, V.E., Grokhovskaya, I.M. and Kryuchnikov, V.N. (1966) Comparative study of biological interrelationships between rickettsiae and ticks of the Superfamily Ixodoidea. *Tezisy Dokl. 1. Akarol. Soveshch.*: 189-190 (T 520, NAMRU-3, Cairo).
- Small, E.B. and Marszalek, D.S. (1969) Scanning electron microscopy of fixed, frozen and dried protozoa. *Science*, 163:1064-1067.
- Stendel, W. and Holm, R. (1975) Surface structure of mouth parts and attachment organs of some ectoparasites. *Vet. Med. Rev.*, 1/2: 207-227.
- Yamaguti, N., Tipton, V.J., Keegan, H.L. and To-shioka, S. (1971) Ticks of Japan, Korea and Ryukyu Islands. *Sci. Bull. Biol. Ser.*, XV(1) *Brigham Young Univ*: p.226.
- Zhmaeva, Z.M. and Pchelkina, A.A. (1966) On the role of Ixodoidea in circulation of *Rickettsia burneti* in nature. *Tezisy Dokl. 1. Akarol. Soveshch.*: 95-96 (T 410, NAMRU-3, Cairo).

＝국문초록＝

## *Ixodes persulcatus* 진드기 雌雄 成蟲에 대한 走査電子顯微鏡的 觀察所見

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*Ixodes persulcatus* 진드기의 表面構造 觀察을 위하여 交尾中에 있는 雌雄 成蟲 標本을 走査電子顯微鏡으로 寫眞을 촬영하여 映像을 分析하였으며 아울러 生態와 疾病과의 關聯性에 대하여 文獻考察을 하였던 바, 다음과 같은 結果를 얻었다.

1. 雌雄標本間에 性別에 따른 外形上의 差異가 明白하였으며 雌蟲은 雄蟲에 比하여 大型의 모습을 나타냈다.
2. 生殖溝는 깊게 잘 發達되어 있으며, 肛門溝는 肛門 주변의 前方으로 明確하고 特徵的인 構造를 나타냈다.
3. 第4觸肢는 短縮되어 있는 形態를 나타내며, 第3觸肢의 腹方上部에 附屬되어 있었다. 齒列에 對한 齒式은 一般的으로 3/3을 나타냈다.
4. 雄蟲에 있어서의 顎體部의 背面後方바닥은 반듯한 直線狀을 나타냈다.
5. 各種 傳染病과 철새와의 關聯性에 있어서 同 진드기類는 媒介體로서 作用하며 疫學上 重要性이 있는 것으로 考察되었다.

### LEGENDS FOR FIGURES

*Ixodes persulcatus* (Schulze, 1930) male and female specimens. Scanning electron microscope (ISI-DS-130, 20 KV).

- Fig. 1.** Aspect of coitus in *Ixodes persulcatus* adult ticks. Notice the large one is a partly fed female showing the specific anal groove extending anteriorly around the anus and the distinct genital groove, while the small one is a male showing the specific lateral groove and the palpi. (16.2×)
- Fig. 2.** Ventral aspect of the female coccygeal part showing the anus and the anteriorly extending anal groove. Notice the distinct genital groove, setae and finger prints on the surface of the abdomen. (39×)
- Fig. 3.** Ventral view of the female capitulum showing the hypostome, articles with ventrointernal setae, ventral process, corona files and some parts of the leg I. (80×)
- Fig. 4.** Dorsal view of the male capitulum showing the articles with ventrointernal setae and the hexagonal basis capitulum. Notice the setae long and short on the surface of the scutum. (189×)
- Fig. 5.** Ventral view of the right legs of the female showing the coxa and trochanter in the leg IV and the pretarsus, pulvillus and claw in the leg III. Also note the pulvillus and tarsus with setae and Haller's organ in the left leg I of the male specimen. (155×)
- Fig. 6.** The tarsus, pulvillus and claw in right leg IV of the female. Notice the spiracular plate (a part of) and the setae and finger prints on the surface of the abdomen. (188×)





