

## Revisiting the morphology of *Acanthocephalus lucii* (Acanthocephala: Echinorhynchidae) in Europe, using SEM

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**Abstract.** *Acanthocephalus lucii* (Müller, 1776) Lühe, 1911 is one of the most widely distributed species of acanthocephalans infecting freshwater fishes throughout Europe. Not much change in its description has taken place by various authors since its original description. Much of its external morphological features remained unknown until recently explored by SEM in our present study from specimens collected from Germany, England, and Finland. The new observations fill an important gap of missing information and enhance our understanding of its morphology. Newly observed features include the proboscis armature and sensory pores, epidermal micropores, and genital orifices and bursa. Discovering new features in an acanthocephalan species that has been well known and studied for over 200 years is a unique contribution.

**Keywords:** *Acanthocephalus lucii*; Acanthocephala; Europe; Morphology; SEM.

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### Introduction

*Acanthocephalus lucii* (Müller, 1776) Lühe, 1911, also described as *Echinorhynchus angustus* Rudolphi, 1802 is found in various European freshwater fishes where it is widely distributed. Some of the many hosts and geographical records are included in Bykhovskii (1936), Lundström (1942), Petrochenko (1956), and Yamaguti (1963). Cyprinid hosts were declared “doubtful” by Lühe (1911). The brief but adequate description of *A. lucii* by Lühe (1911) included measurements of trunk, proboscis, neck, proboscis receptacle, and eggs,

provided the proboscis hooks formula, described the shape of the hook roots, lemnisci, and the male reproductive system, and included 4 accurate figures of a male, a proboscis, a rooted proboscis hook, and an egg (Figures 7-10). Subsequent descriptive accounts by many observers including Kostylew (1916), Meyer (1932), Markowski (1933), Bykhovskii (1962), Yamaguti (1963), and Olburs (1978) were primarily based on Lühe’s (1911) description and used his or Meyer’s (1932) very similar illustrations. The description by Petrochenko (1956) was based on his own specimens but using Meyer’s (1932) illustrations, and those by

Golvan (1969) and Florescu and Ienistea (1984) were based on their own specimens and illustrations.

None of the morphological features studied and reported in our work has ever been or could have ever been described in any one or more of the above reports because of the absence of SEM technology then.

### Materials and methods

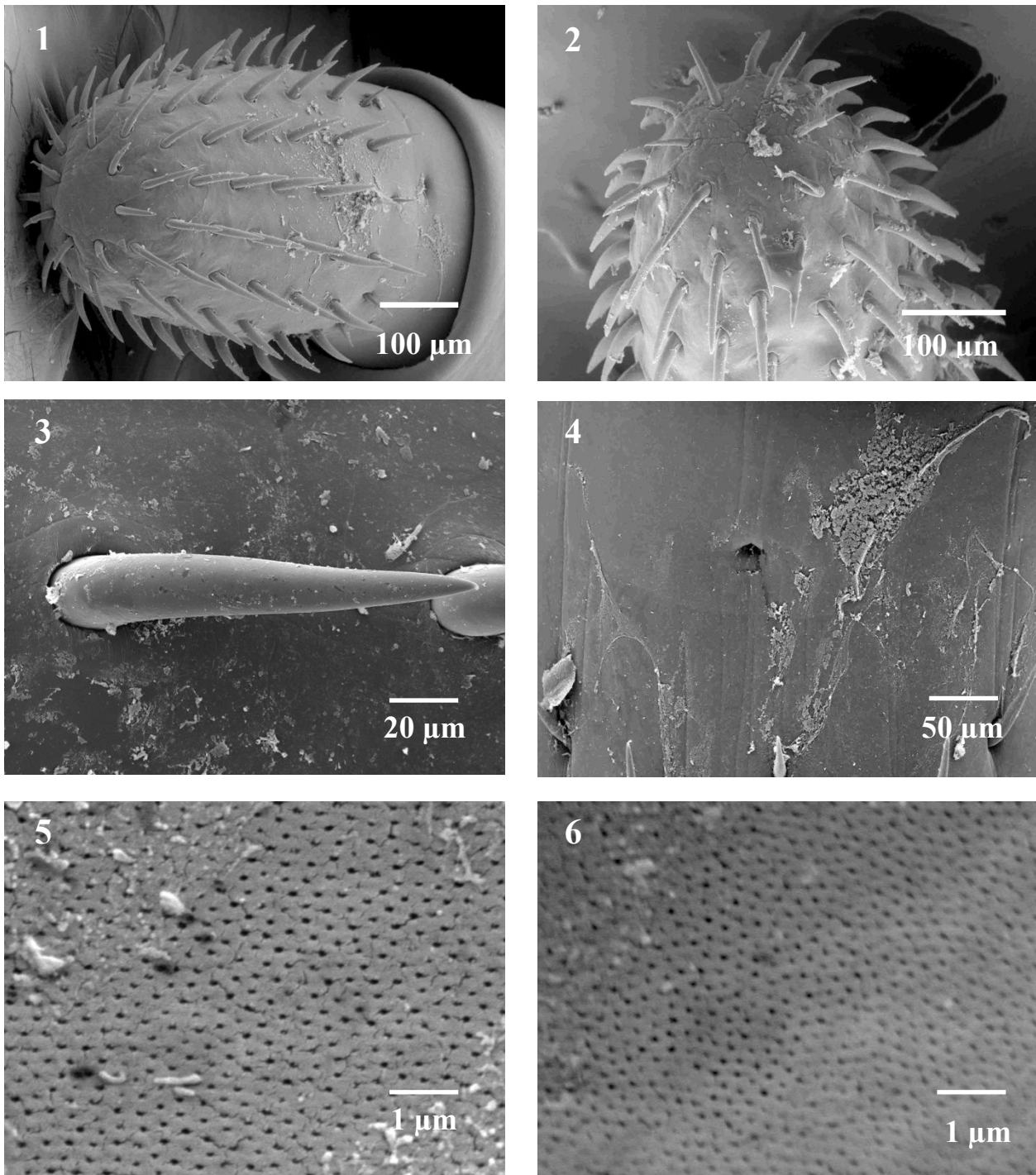
Over 1 hundred specimens of *A. lucii* collected from perch *Perca fluviatilis* L. and pike, *Esox lucius* L. were collected in England, Germany, and Finland from 1985 to 1990 courtesy of C.R. Kennedy, H. Taraschewski, and E.T. Valtonen, respectively. The specimens were preserved in 70% ethanol and shipped to our Arizona facility for processing. For SEM studies, 23 specimens were placed in critical-point drying baskets and dehydrated using ethanol series of 95% and 3 N 100% for at least 10 min per soak followed by critical point drying (Lee, 1992). Samples were mounted on SEM sample mounts, gold coated and observed with a scanning electron microscope (XL30 ESEMFEI; FEI, Hillsboro, Oregon). Digital images of the structures were obtained using digital imaging software attached to a computer.

### Results and discussion

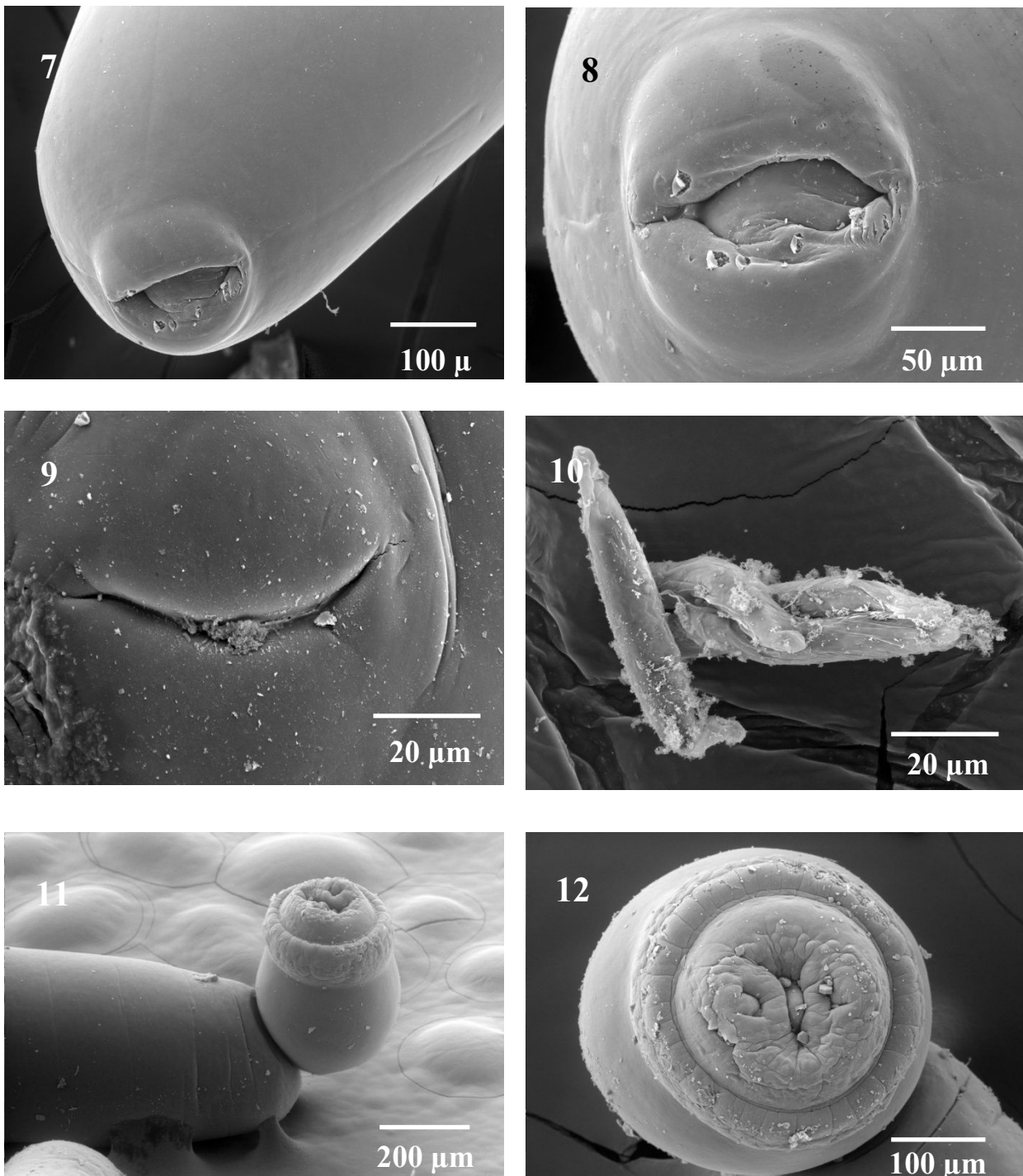
Since its original description by Müller, 1776 and Lühe, 1911, descriptive accounts of *A. lucii* were provided by many observers including Kostylov (1916), Meyer (1932), Markowski (1933), Petrochenko (1956), Bykhovskii (1962), Yamaguti (1963), and Olburs (1978), Golvan (1969), and Florescu (1984), among others. In none of these accounts was there any reference made to the features seen by SEM in the present study. These include the cylindrical but medially

swollen proboscis (figure 1) with a bold, flat epical end (figures 1, 2). Paired sensory pits are found in the neck (figures 1, 4). Hooks are uniformly slender throughout the length of the proboscis (figure 3) but smallest posteriorly (figure 1). Trunk epidermis with many micropores of different size and distribution being larger and more widely spaced in the anterior trunk (figure 5) but smaller and more numerous posteriorly (figure 6). See Amin et al. (2009) for implications to differential absorption. The female gonopore is terminal, slit-shaped laterally in an elevated orifice (figures 7-9). Eggs are elongate-fusiform, smooth, with no corrugations or special topography (figure 10). Bursa directed ventral (figure 11), heavily muscular with prominent and well defined rim and elevated medial tissue; no sensory structures were observed (figures 11, 12).

While one or more of these features can be found in other acanthocephalan species, the combination of all the presented traits (figures 1-12) appear to be unique to *A. lucii*. For example, *Acanthocephalus ranae* (Schrank, 1788) Lühe, 1911 has similar eggs, female gonopore, and bursa which however has sensory tubercles (see Heckmann et al., 2011); female *Pomphorhynchus spindletruncatus* Amin, Abdullah, and Mhaisen, 2003 has similar genital opening but the orifice is not elevated (see Heckmann et al., 2010); *Rhadinorhynchus dorsoventrospinosus* Amin, Heckmann, and Ha (2011) has similar eggs and comparable bursa (see Amin et al., 2011); female *Rhadinorhynchus ornatus* Van cleave, 1918 has similar gonopore and orifice (see Amin et al., 2009). The epidermal micropores are similar to those reported in other acanthocephalans investigated except for *R. ornatus* that has microtrichs (Amin et al., 2009).



**Figures 1-6.** *Acanthocephalus lucii* from perch and pike in Europe. **1.** The proboscis of a female worm showing its cylindrical-swollen at middle shape, small posterior hooks, and sensory pit in neck. **2.** The same proboscis in Figure 1 tipped to show the flat bare apical end. **3.** A hook in the middle of the proboscis showing its slender shape and the lack of epidermal elevations at insertion point. **4.** A sensory pit in the neck of a worm. **5.** Epidermal micropores at anterior trunk, relatively large and widely spaced. **6.** Epidermal micropores at posterior trunk, smaller and more tightly spaced.



**Figures 7-12.** *Acanthocephalus lucii* from perch and pike in Europe. **7.** Posterior end of a female worm's trunk showing the laterally slit, elevated genital orifice. **8.** Enlarged view of the genital orifice in Figure 7. **9.** Genital opening of another female worm with closed vaginal lips showing slightly curved slit-shaped opening. **10.** Eggs. **11.** Lateral view of a bursa at right angle to the trunk. **12.** En face view of the same bursa in Figure 11 showing its highly muscular structure and prominent rim.

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