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Personal report

Scanning electron microscopy of legs of two species of sucking lice (Anoplura: Phthiraptera)

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ABSTRACT

Pretarsal, tarsal and tibial structures of the forelegs, midlegs and hindlegs of *Pediculus humanus* of humans and of *Haematopinus apri* Goureau, 1866 (Phthiraptera), a parasite of feral hogs, were studied using light microscopy and scanning electron microscopy. Details of the tibial thumb-like process (tl) with the spine of the thumb (spn), tarsal apophysis (ta) and the coupled finger-like process (cfl) can be observed in the leg photomicrograph of both species. A frontal view of the leg in open position shows the articulation of the claw: the structures of an open-closed system, a tooth row (te), rack-system (rs) and two telescopic columns (tc) which are present near the base of the claw in both species. In *H. apri*, we observed a pad-like structure, the flap-like tibial lobe (fl) on the ventral surface on the tarsus, the euplantulae, with several sensilla basiconica, which is present in each leg.

1. Introduction

Several authors have described the leg structures of the sucking lice (Anoplura), *Pediculus humanus* and *Haematopinus apri*. The main objective in the current study was to describe the ultrastructure of the tarsi in both species and to attempt to clarify and unify some of tarsus terms used.

Pediculidae leach, 1817. *P. humanus*. The legs were described by Keilin and Nuttall (1930) (p. 3). Those authors showed the main structures of the legs, also noting the highly developed thumb (th), the thumb chitinous spine (spn) and the lamella (lm) and how the whole structure of the male was larger than that of the female. According to Séguy (1944) (pp. 454–455, 457) the legs are robust; in the male, the forelegs (legs I) are stronger than the midlegs (legs II) and the hindlegs (legs III); the tarsus has a sensorial organ. All the legs are subequal in shape and size and each with a long acuminate claw; tibial thumbs developed, each with a spiniform seta (Kim and Ludwig, 1978) (p. 276). For Szczesna (1978) (pp. 594–596), the legs are short, strong and composed of five segments. The tibia has a tibial thumb-like process (tl) which forms a pincer with the mobile tarsal claw. There are also paired euplantulae on the sole of the tarsus, to prevent slipping along the hair and several sense organs: sensilla trichoidea, simple sensory hairs or complex sensory hairs with no morphological difference between them. There are also long, pointed hair-shaped sensory receptors set in membranous base: the sensilla basiconica or thick-walled pegs (twp).

Haematopinidae Enderlein, 1904. *H. suis*. The tibia (Séguy, 1944) (p. 414), is larger than the femur, bearing an apical and inner projection (ap), without or armed with one or two spiniform setae (ss). The tarsus (ts) is unsegmented with a more or less spinous pretarsal sclerite (ps) and armed with only one strong claw (cl), which can be retracted over the apical projection. Above the pretarsal sclerite is the tarsal apophysis (ta). Posterior to the insertion of the claw there is a tarsal organ: the unguitractor (ung). The legs of members of this family (Kim and Ludwig, 1978) (pp. 257, 268, 271) are strongly developed and subequal in size and shape, and each has a discotibial process. The tarsus is unsegmented with a strong, stout claw. Each tibia has a flap-like tibial lobe bearing a few spiniform setae, and well-developed tibial thumbs, which terminate in an apical spiniform seta.

In the general description of the insect legs (Richards and Davies, 1977) (p. 48) the tarsal apex bears a group of structures which form the *pretarsus*, the terminal segment of the legs. This extends into a single or paired claws, and between them, on the ventral surface, the pretarsus is supported by a median *unguitractor plate* to which the apodeme of the flexor muscle of the claws is attached. Above and in front of this plate, the pretarsus expands into a median lobe or *arolium*. Among the Diptera there are two

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Table 1
Different terminology used by various authors in their drawings of the structures of the forelegs of genus *Pediculus* and *Haematopinus*.

Pediculus humanus				*Haematopinus suis*	*Haematopinus* sp.
Keilin and Nuttall (1930)		Séguy (1944) (Fig. 1C)	Szczesna (1978) (Fig. 1D)	Séguy (1944) (Fig. 1E)	Kim and Ludwig (1978) (Fig. 1F)
Male (Fig. 1A)	Female (Fig. 1B)				
lm: lamella	lm: lamella	–	eu: euplantulae	ap: apical projection	tt: tibial thumb
spn: chitinous spine of the thumb	spn: chitinous spine of the thumb	so: sensorial organ	tw: thick-walled peg or sensilla basiconica	ps: pretarsal sclerite	dtp: discotibial process
th: thumb	th: thumb	–	tl: tibial thumb-like process	ss: spiniform setae	ss: spiniform setae
–	–	–	–	ta: tarsal apophysis	–
–	–	–	–	ung: unguitractor	–

lobes or *pulvilli* beneath the claws, often with an arolium between them, or instead of an arolium, the plantar sclerite distal to the unguitractor plate may extend into a median bristle or *empodium*. On the underside of the tarsal segments, there are often pulvillus-like organs or *plantulae*. The arolium, pulvilli and plantulae are pad-like organs which allow smooth or steep surfaces to be grasped.

According to Torre-Bueno (1985), an *arolium* is one of the lobes of the pulvillus; an e*mpodium* is a process of the unguitarctor (often used erroneously to apply to a pulvillus); an e*uplantula* is a pad-like structure on the ventral surface of the tarsus; a *pulvillus* is a pad-like structure between the tarsal claws; an *unguifer* is an articulation of the claw; and an *unguitractor plate* is a ventral sclerite of the pretarsus.

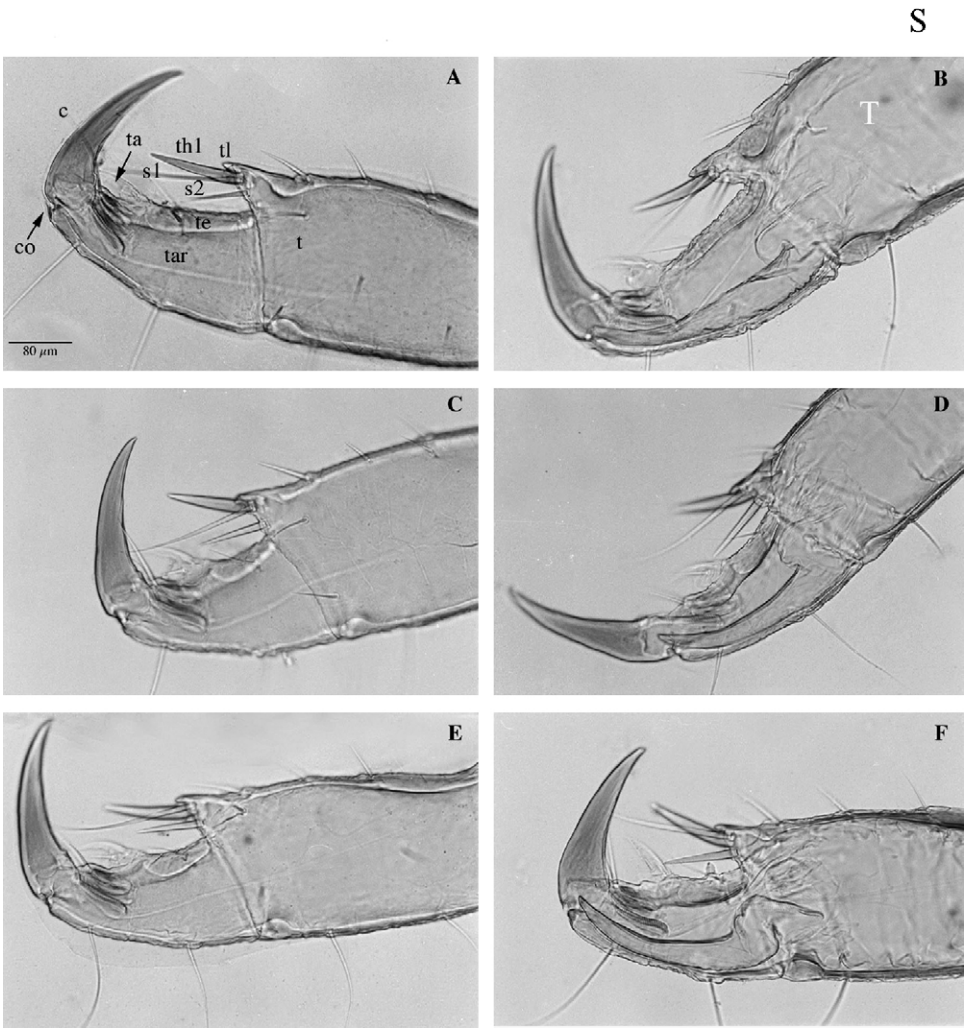

Fig. 1. Light (LM) photographs of *Pediculus humanus*. (A, C, E) I, II, III left legs; (B, D, F,) I, II, III right legs. Structures of tarsus (tar) and tibia (t); (c) claw; (co) condyle; (s1, s2) spiniform setae; (ta) tarsal apophysis; (te) teeth; (th1) tactile hair; (tl) tibial thumb-like process with the spine of the thumb. Bars: 80 μm.

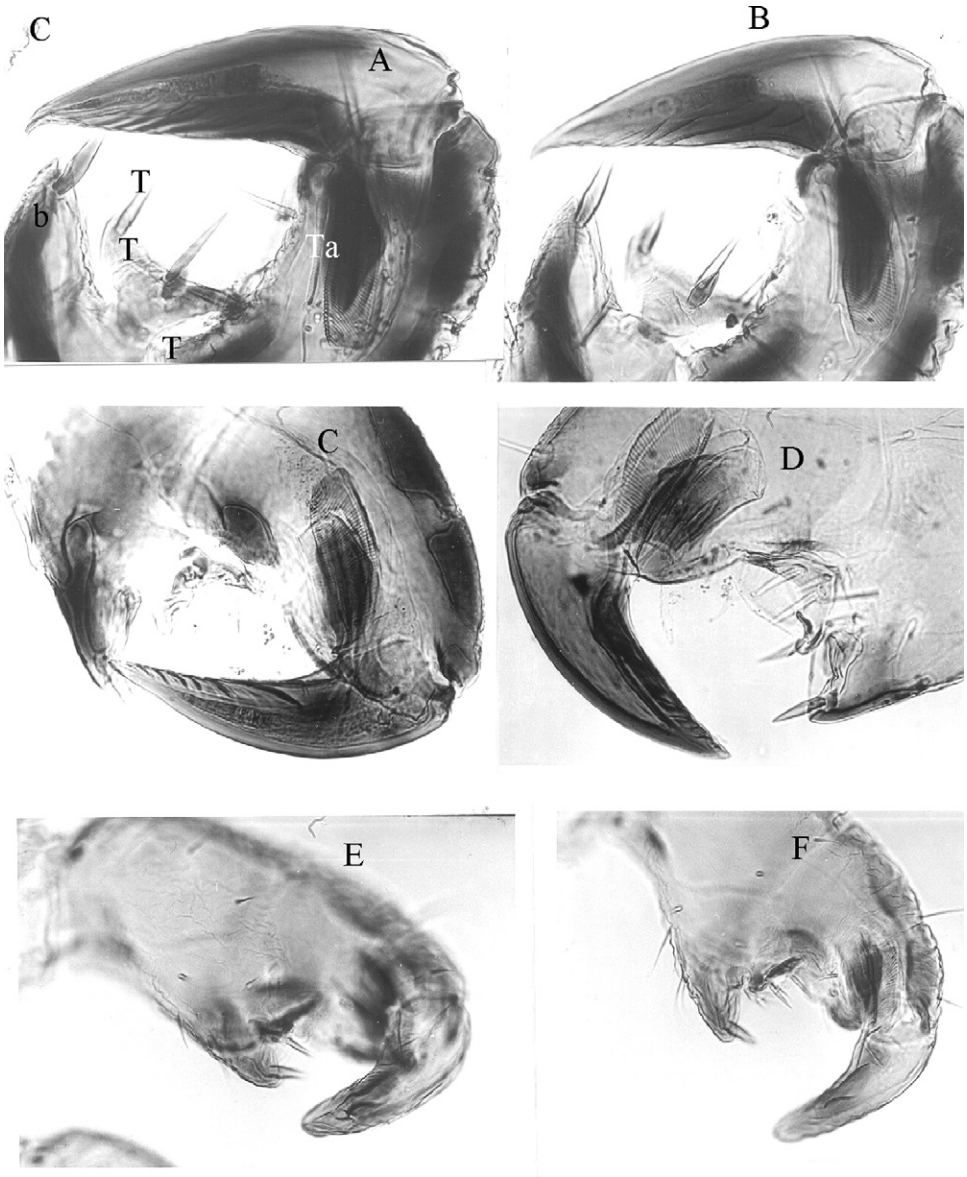

Fig. 2. LM photographs of *Haematopinus apri*. (A, C, E) I, II, III left legs; (B, D, F) I, II, III right legs. Structures of tarsus (tar) and tibia (t); (b) sensilla basiconica; (c) claw; (s) spiniform setae; (ta) tarsal apophysis; (th) thumb; (tl) thumb-like process. Bars: 80 μm.

2. Materials and methods

Ten specimens each of *H. apri* (Goureau) a parasite of wild hogs, *Sus scrofa* (L.), in Eurasia, and the human body louse *P. humanus*, were studied using light microscopy (LM) and scanning electron microscroscopy (SEM) to determine the morphology of the leg structures. Routine methodology was used for preparing specimens for light microscopy (Martín Mateo, 1994). Preparation routines for scanning electron microscopy included: (a) storage in a mixture of 70% alcohol and 30% ether; (b) cleaning with double distilled water and ether (three washes of 10 min each); (c) dehydration by lyophilization at 40 °C and 125 bars; (d) mounting on a standard pin using double-sided tape; (e) sputter-coating with gold in the presence of argon gas for 2 min; (f) observation in a Zeiss DSM SEM 950 (Soler Cruz, 1995; Soler Cruz and Martín Mateo, 1996, 1998, 2001). Table 1 includes the terms used to name the structures by other previous authors.

3. Results and discussion

P. humanus. Leg I (Fig. 1A and B) (Fig. 3A–G). Foreleg pretarsal, tarsal (tar) and tibial (t) structures are shown, in a closed position (Fig. 3A) with the tibial thumb-like process (tl) and the spine of the thumb (spn) (Fig. 3B) overlaying the tarsal apophysis of the pretarsal region (Fig. 3C). In this position, a coupled finger-like process (cfl) is retracted under the closed claw (c) (Fig. 3D). In an open position (Fig. 1A) and (Fig. 3E–G) the coupled finger-like process is relaxed. These processes could provide the insect with information on the claw opening angle. The relative position between structures such as the claw, tarsal apophysis and tibial thumb-like process is shown (Fig. 3C) and is similar to that in drawings by previous authors, where the lm (Keilin and Nuttall, 1930) (Table 1) or euplantulae (Szczesna, 1978) represent the tarsal apophysis. The tibial thumb-like process represents the chitinous spine of the thumb of Keilin and Nuttall (1930), the sensorial organ of Séguy

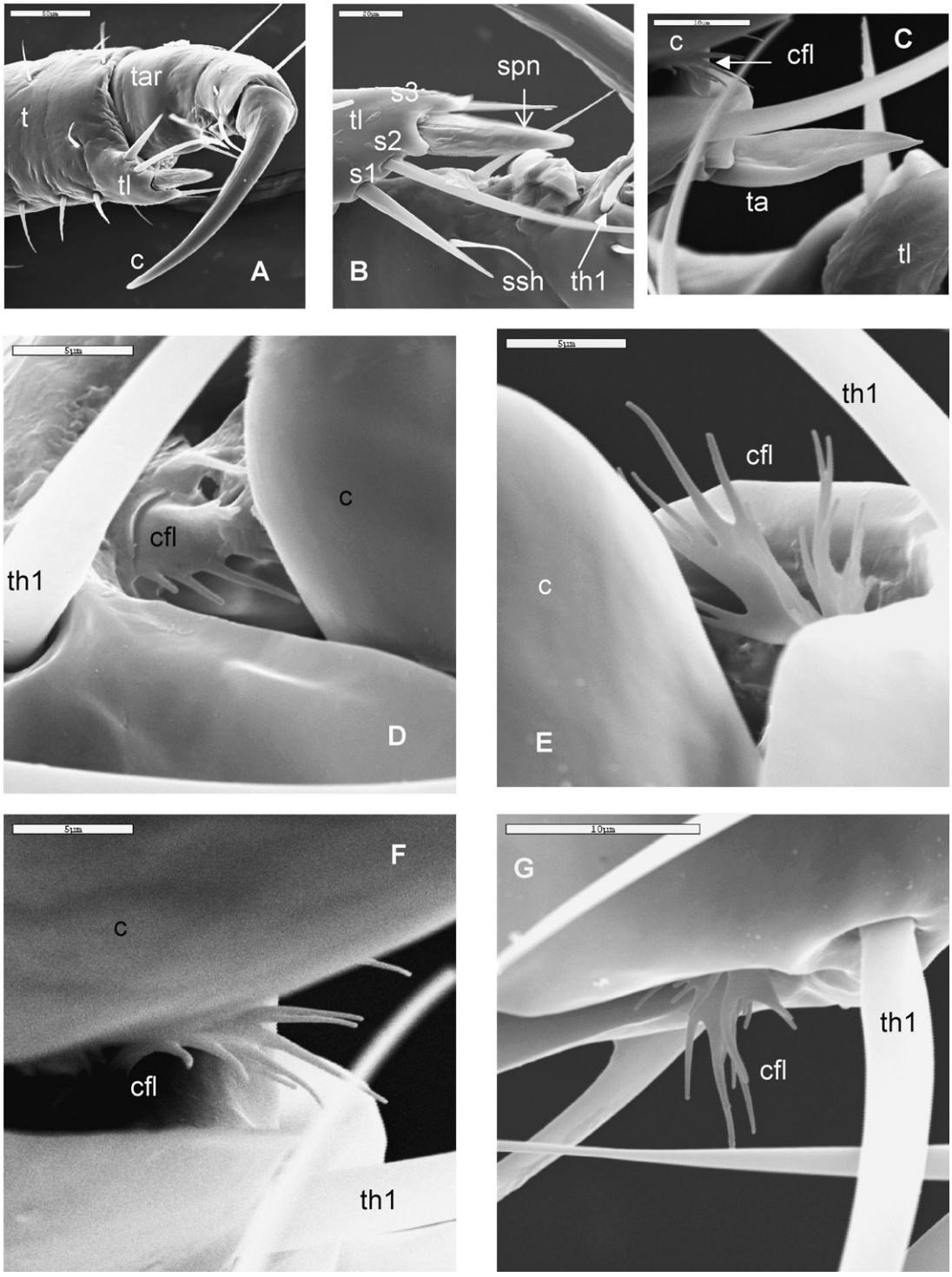

Fig. 3. SEM photomicrographs of *Pediculus humanus*. (A–G) Leg I. (A) Claw (c) in a closed position and the tibial thumb-like process (tl) of the tibia (t), not retracted, over the tarsus (tar). (B and C) Ventral region of the tarsus. Spine of the thumb (spn), coupled finger-like process (cfl) retracted under the closed claw and tarsal apophysis (ta). Spiniform seta (s: s1–s3). Simple sensory hair (ssh). Tactile hair (th1). (D) cfl inside a notch. (E–G) This process in open position and (F) retracted over the tarsus. Bars: 50 μm (A); 20 μm (B); 10 μm (C and G); 5 μm (D–F).

(1944) or the thick-walled peg or sensilla basiconica (twp) of Szczesna (1978). Other related sensory structures like the spiniform setae (s1–s3), simple sensory hair (ssh) or tactile hair (th1) are shown.

Leg II (Fig. 1C and D) (Fig. 4A–E) and leg III (Fig. 1E and F) (Fig. 4F–H). Frontal views of the leg II (Fig. 4A) and leg III (Fig. 4F) show the region of the pretarsus. The open-closed system is formed by several structures: a central rack system

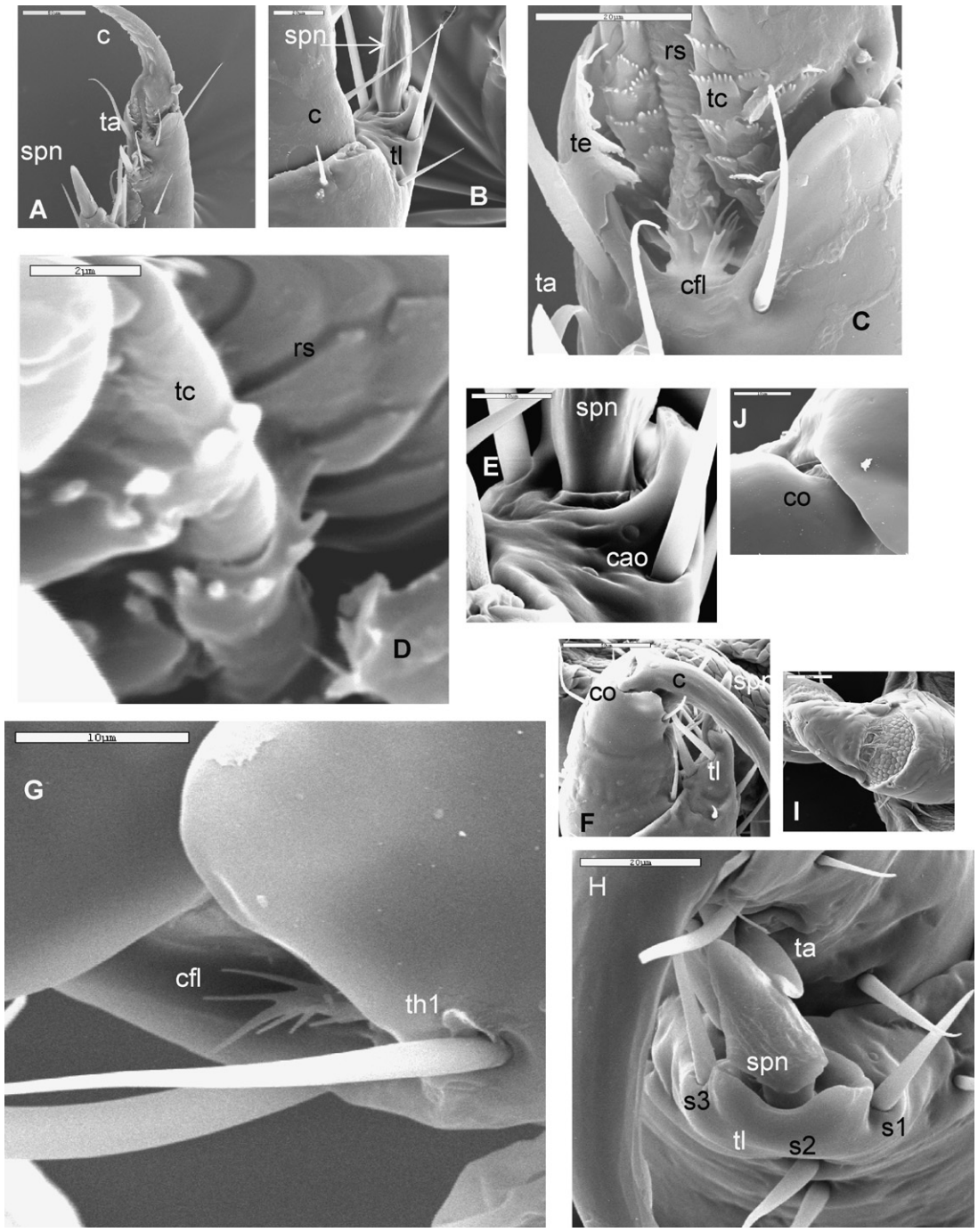

Fig. 4. SEM photomicrograph of *Pediculus humanus*. (A–E) Leg II. (A) Claw (c) in open position, with tarsal apophysis (ta) and spine (spn) of the tibial thumb-like process (tl) (B). (E) Detail of the spine insert in this tibial process (tl). Campaniform organs (cao) (C). Open-closed system of the legs in an open position: teeth row (te), coupled finger-like process (cfl), rack-system (rs) and tc (D) detail of a telescopic column. (F–H) Leg III. (F) Leg in closed position. (G) cfl near a tactile hair (th1) an retracted position. (H) Spine of the tl resting on the ta. Spiniform setae (s: s1–s3) near the notch. (I) Proprioceptors within leg II cavity. (J) Condyle (co) of leg I. Bars: 50 μm (A, F, I); 20 μm (B, C, H); 10 μm (E, G, J); 2 μm (D).

(rs) and two lateral telescopic columns (tc) (Fig. 4C and D). Along its base, a coupled finger-like process (cfl), with possible sensory function, is present on legs II (Fig. 4C) and leg III (Fig. 4G). Different views of the tl with the own spn are shown (Fig. 4B and E). It is situated, by leg II (Fig. 4E) and III (Fig. 4H) in a cuticular notch. This last figure shows how the ta overlays the spn of tl. The condyle (process by means of which an appendage is articulated into a cavity, Torre-Bueno, 1985) of leg I (Fig. 4I) and the proprioceptor, an internal sense organ, of leg II (Fig. 4J) are also shown.

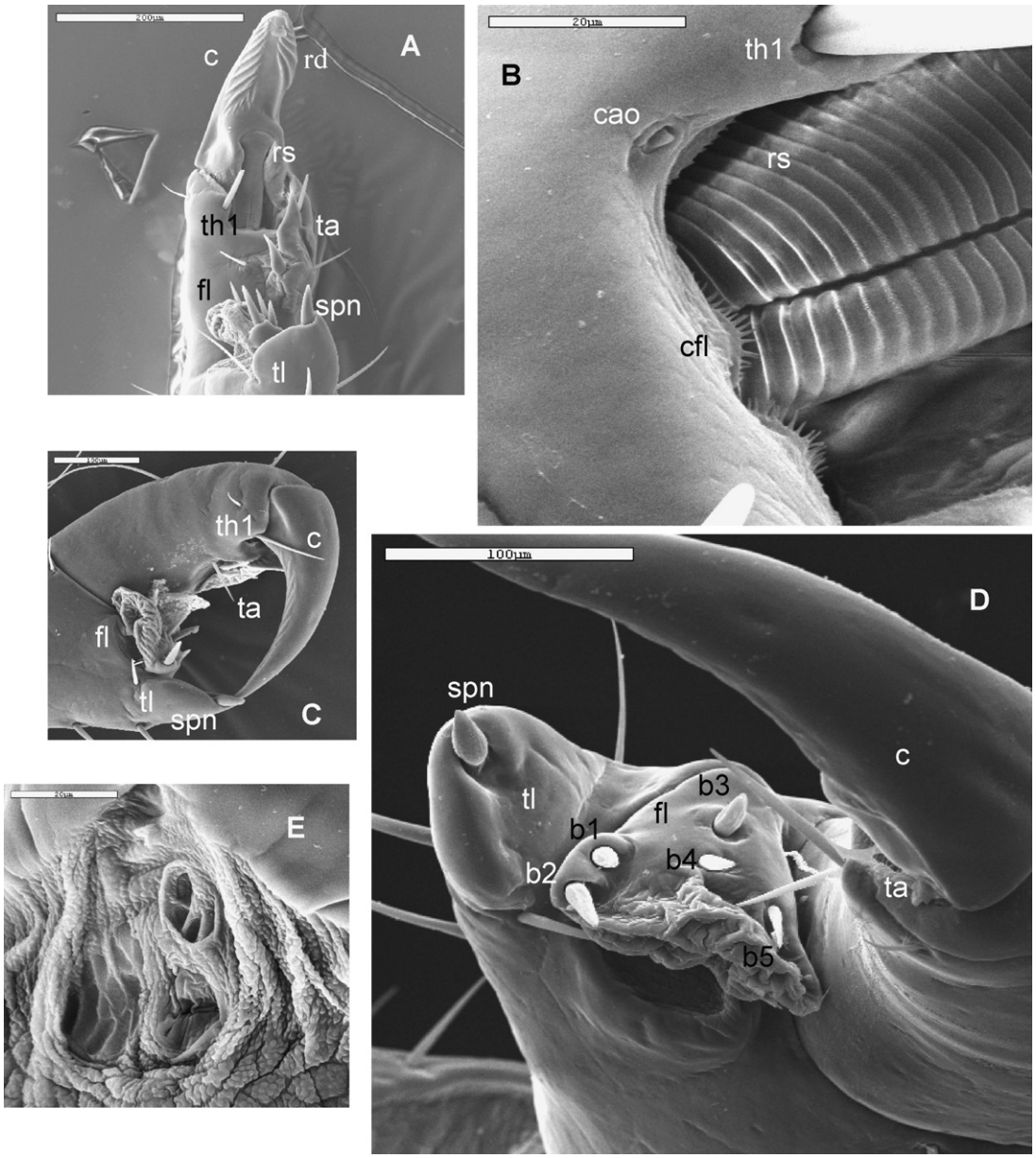

Fig. 5. SEM photomicrograph of *Haematopinus apri*. (A–E) Leg I. Ridges (rd) of the claw (c) in open (A) or closed (C) position showing the flap-like tibial lobe (fl), the rack-system (rs), spine (spn) of the tibial thumb-like process (tl) and the tarsal apophysis (ta). (B) Open-closed system of the legs with detail of rs and coupled finger-like process (cfl). Tactile hair (th1). Campaniform organs (cao). (D) fl with five spiniform setae or sensilla basiconica (b1–b5). (E) Proprioceptors lying within leg cavity. Bars: 200 μm (A); 100 μm (C and D); 20 μm (B and E).

H. apri. Leg I (Fig. 2A and B) (Fig. 5A–J). In the frontal views, (Fig. 2A) (Fig. 5A, C, F and G) the morphology of the "rack-system" can be seen. Fig. 5D shows the relative position between the claw, tarsal apophysis and thumb-like process. Situated in the middle of these structures is the flap-like tibial lobe (Fig. 5E), the pretarsal sclerite of Séguy (1944) or the discotibial process (dtp) of Kim and Ludwig (1978) (Table 1). This lobe might also represent the euplantula, "a pad-like structure on the ventral surface of the tarsus Torre-Bueno (1985)". From another position, this euplantula is shown in Fig. 5H–J. Five grooved spiniform setae (b1–b5), similar to those shown in Séguy's (1944) drawing are inserted on this pad-like structure. Leg II (Fig. 2C and D) (Fig. 6A–H) and leg III (Fig. 2E and F) (Fig. 6I and J). Large, stout and ridged claws (Fig. 6E and I), very similar structures to those on leg I can be found in leg II (Fig. 6A–C) and leg III (Fig. 6H). The "rack-system" is present on both legs (Fig. 6D and G) and could be a system to lock the position of the claw", as is the pad-like structure (Fig. 6F and J), and this always has three (b1–b3) spiniform setae. According to Torre-Bueno (1985) a proprioceptor is "a true internal sense organ lying within the body cavity and responding to internal conditions of the organism". Fig. 6K–O, shows these structures which are present in both species studied.

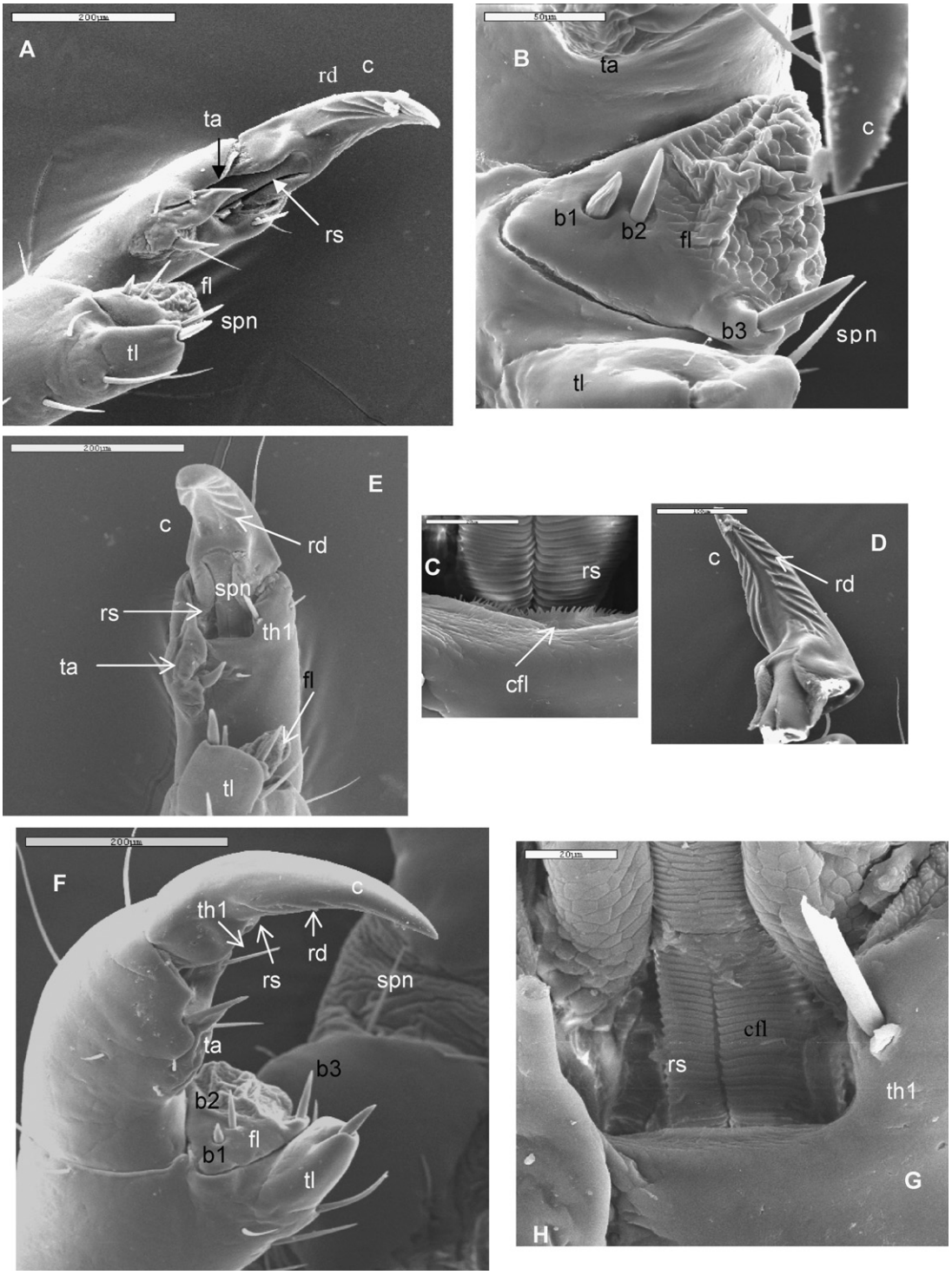

Fig. 6. SEM photomicrographs of *Haematopinus apri*. (A–G) Leg II. (A–D) Leg III (E–G) Claw (c) in open position (A, leg II and E, leg III), showing the flap-like tibial lobe (fl), rack-system (rs), spine (spn) of the tibial thumb-like process (tl) and the tarsal apophysis (ta). (D) Detail of ridges (rd) in the ventral part of the claw of leg II. Flap-like tibial lobe of leg II (B) and leg III (F) bearing three (b1–b3) spiniform setae. (C, leg II and G, leg III) Detail of the rs and the coupled finger-like process (cfl). Bars: 200 μm (A, E, F); 100 μm (D); 50 μm (B); 20 μm (C and G).

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Glossary

B, (b1–b5): sensilla basiconica
C: claw
Cao: campaniform organs
Cfl: coupled finger-like process
Co: condyle
Fl: flap-like tibial lobe
Rd: ridges of the claw
Rs: rack-system
S, (s1, s2, s3): spiniform seta
Spn: spine of the thumb
Ssh: simple sensory hair
T: tibia
Ta: tarsal apophysis
Tar: tarsus
Tc: telescopic column
Te: tooth row
Th1: tactile hair
Tl: tibial thumb-like process