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Morphological studies on sense organs of the adult female of the true spider *Cheiracanthium isiacum* (Araneae: Cheiracanthiidae) at Assiut Governorate, Egypt.

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ABSTRACT

All spiders having different types of hairs. The spider's body hair and spines are hollow and highly sensitive to touch and to vibrations. Adult female of *Cheiracanthium isiacum* has different types of sensory organs, like slit sensilla (mechanoreceptors) that detects cuticular strains and vibrations, flexible hair sensilla (trichobothria) that detects air movements, chemosensitive hairs, trichoid sensilla and different types of setae. Adult females have dense hair pads on the ventral side of their distal end of tarsi on the walking legs. These dense hairs are called scopulate hairs. The fine structural analysis of these scopulate hairs revealed that they lack the brush-like structure and they have tiny "end feet" that is typical for such adhesive hairs. Contact chemoreceptors occur on all parts of the body particularly concentrated on the distal segments of walking legs. The tactile taste hairs are found on the mouth, chelicerae and spinnerets may act as chemoreceptors. The aim of the present study is to illustrate the morphology of different sensory organs on all parts of the body of the spider *Cheiracanthium isiacum*. Using light and scanning electron microscopy. The study revealed the presence of different sensillae including trichodea, slit sense organ, tactile hairs, trichobothria and different types of setae.

INTRODUCTION

Cheiracanthium isiacum (1) is a species of spiders belonging to family Cheiracanthiidae. This family is known as the black-footed yellow sac. They get this common name from their appearance. Family Cheiracanthiidae was created by (2), it is one of the big families of spiders with united genera from several other families. There are 14 genera and 363 species occur worldwide, 80 species in Africa and 9 species in Egypt Egypt (3, 4) and . Cheiracanthiidae are free-living, cryptic spiders. They are

common around the world and wide spread of habitats, including trees, forest floors, fruit orchards and other agricultural areas, and shrubs surrounding open fields (5-7) They distribute in different governorates in Egypt; Qena, Sohag, Assuit, Beni Suef, El-Fayum, Siwa Oasis, El-Giza, Cairo, Nile Delta and El-Qalyubia, (8-13). Yellow sac spiders stay near their eggs and defend them. They are active at night, leaving their sac to hunt at night. They prefer to live around bushes, gardens, leaf piles, trees and woodpiles (12). They are good climbers and spread in high places or dark hollows where they feel safe (14, 15). Members of this family are hiding in smooth silken retreats**,** which found in the cracks of the stems of the trees. All species are predators, chasing prey instead of catching it in webs (11). These spiders come into contact with people if they should be trapped between a person's skin and bed sheets, clothing, or shoes (16). The yellow sac spiders are venomous and their bites contain cytotoxin, resulting in necrosis and they bite if a person excites the spider while gardening or working in a location of habitat (17). They eat insects especially prey on caterpillars, other spiders, their mates and sometimes their own eggs. The yellow sac spiders don't make webs, they build a sac or silken tube in protected places like beneath a leaf or at the meeting point of a ceiling and wall (18). Spiders have sensilla in their exoskeleton which can be considered a biological version of technical strain; these sensory receptors measure the effects of the outer environments. *Cheiracanthium isiacum* is similar to other spiders. It has different types of hairs which use them for sensing their outerling world. Sensory organs detect stimuli in their own modality (19). Spiders can detect touch, vibrations and smells through different sensory structures connected to their nervous system (6).

MATERIALS AND METHODS

Specimens of *Cheiracanthium isiacum* were collected by sweep net, pitfall trapping and hand collecting from the canopy, trunks of citrus tree located in the farm of Assiut Agriculture College, located at Assiut governorate, Egypt. In the season of collection only females were recorded in numerous numbers. Specimens were washed carefully by water and then dissected and saved each part in 70% ethanol for light microscope-investigation and all samples were brushed using a thin painting brush of synthetic fibers, following the direction of the hair. Before drying, some hairs had to be removed with fine forceps to expose structures. For preparing samples for (SEM), all samples were dried after dehydration in ethanol series. Each sample was mounted on a separate aluminum stub, using adhesive carbon tabs or adhesive copper tape. During mounting, some further depilation was made with fine forceps, the loose hairs or dirt then removed with brush and a jet of air blowing through a thin pipette connected to a rubber tube. To allow for better conductivity, once positioned on the adhesive medium, the borders of the pieces were glued to the conductive substrate with colloidal graphite on isopropanol base. Such conductive paint reduces the charging of the sample under the SEM, and further secures

the piece. The preparation identifier was engraved on each stub with a needle to make it visible in the SEM monitor with the aid of binocular stereomicroscope and scanning electron microscope. The identification of specimens were carried out on the light of the available taxonomical knowledge. Many keys, papers and catalogues were used for identification of this recorded species including (20-29)

RESULTS

Members of this species are known as the black-footed spiders or yellow sac spiders. The body of adult female of *Cheiracanthium isiacum* is divided into two parts: the prosoma and opisthosoma. The length of prosoma is relatively longer than width, not convex above and without foveal marks. It is of yellow colour, clothed with short, fine and pale hairs (Fig.1A). On the ventral side of prosoma of female, there is sternum taking heart shaped, yellowish in color, wider than long, slightly convex and broadly truncated posteriorly. Sternum attached anteriorly with the chelicera, mouthparts and female pedipalps (Fig.1B). The opisothoma (abdomen) takes a globose shape, very wide and contains the spider's internal organs (Fig.1C).

Types of sense organs in adult female of *Cheiracanthium isiacum*:

Eyes are eight blacked located on the frontal side of prosoma, arranged in two slightly parallel transverse straight rows and the ocular region distinguishes with blackish brown area (Fig. 1D). The antero-median eyes are the largest, while the postero-median ones are nearly equal in size and smaller than the antero-lateral eyes (Fig. 2A). The antero and postero-median eyes form a square shape (Fig.2B). The lateral pair of eyes are slightly obliquely placed on a tubercle, but not contiguous to each other and the clypeus region is relatively very short (Fig. 2C).

Sensilla trichodea is present between eyes in few numbers which take two shapes slightly curved with one pore at the distal end and straight short type (Fig. 2C) and tactile sensory hairs are distributed on the dorsal surface of prosoma. Enlarged tactile sensory hairs show that these hairs bear small barbs and long tapering end (Fig. 2D).

The basal segments (coxa) of the palps are enlarged to form the chewing mouthparts, the endites and the labium. The labium is a plate, situated between the two endites (maxilla) and is straight elongated, yellow near the base, and red-brown above (Fig. 3A). The maxilla is yellow at the base, red-brown on the upper half, longer than wide, black and covered with strong black tactile taste hairs (Fig. 3B). The promargins of the endites are fringed with dense tactile taste hairs which may use to filter the liquefied food. There are dense tactile taste hairs accumulated on the maxilla and labium (Fig. 3C). Slightly curved trichoid sensilla with many tiny sensory hairs on each maxilla are present (Fig. 3D). These sensilla may have mechano-chemosensory and gustatory function. The rim of the endite bears cuticular, serrated ridges known as the serrula (teeth) which used in a saw-

like fashion to cut prey (Figs. 3(E&F)). Below labium and maxilla, tiny sensory hairs are present which may act as chemosensory receptors.

Chelicerae are long and strong and the cheliceral furrows have two pro-marginal teeth and two retro-marginal teeth (Fig. 4A). Fangs are relatively long and moderately strong, straight; slightly projecting forwards and has red-brown color (Fig. 4B). **Female stridulatory ridges on chelicera** are present on the ventral side of female chelicera near the lateral end; these may have chemo-mechano sensory function (Fig. 4C). Dense tactile taste sensory hairs accumulated around fangs and teeth (Figs. 4(D&E). Teeth are found on two both margins of the fang furrow. Cheliceral teeth are important as taxonomic characteristics for taxonomists (Fig. 4F). It is used in a saw-like to cut prey, seizing prey, carrying egg cocoons, digging soil and making noise and used in sexual and agonistic displays. The promargins are fringed with scopulae, a dense cover of hairs used to filter the liquefied food (Figs. 4G).

Trichobothria are hair sensilla of different terrestrial arthropods and characterized by a cup-shaped cuticular structure, named bothrium, in which the hair is inserted. **Thickened trichobothria** with different length, blunt tip and large prominent sockets are present on the dorsal and ventral side of female chelicerae, pedipalps and all walking legs. Female palpi are brightly yellowish and their ends banded with red and black color and small needle-like claw (Fig. 5A) and, also covered by thickened trichobothria on the dorsal and ventral side of female Palpi (Fig. 5B).

The chemosensitive hairs: They are present on the distal end of the female palpi and on the ventral side (Figs. 5 (C&D)**.** The chemosensitive hairs has a bent hair shaft which is smooth at the base but bears spiny extensions more distally and the hair tip is blunt and exhibits a small pore that connects the outside with dendritic nerve fibers inside the hair shaft (Figs. 6(A&B).

Slit sensilla (Lyriform organ): They take slit-shaped holes in the cuticular exoskeleton. They are present singly in loose groups and in tight groups and called lyriform organ. They are present on the ventral side of the joint between the metatarsus and tibia in the fourth left and right walking legs and on the ventral side of tibia of the fourth left leg (Figs. 6(C&D). The Opisthosoma of the spider is relatively very wide. Its dorsal and ventral sides contain less numbers of trichobothria (Figs. 7(A&B). Epigyne has a bean-shaped and epigynal field broader than long. It looks like a very flat depression, with raised margins in which the posteriors and the laterals are more developed than the anterior ones (Fig. 7C). The copulatory openings locate laterally within that depression. Spinnerets are short, small, and yellowish-brown to pale yellow and covered with short fine white hairs. The anterior pair is the largest and segmented. The posterior pair is the longest one, while the median pair is the smallest (Fig.7D). Colulus are present. The anal tubercle has a yellowish-green to pale yellow in color and its tip covered with strong black hairs. The walking legs are long, moderately strong; their colour is yellow, covered

by thickened trichobothria with different length and more than numbers of spines, each tarsus ends with two claws and scopulae hairs between them. Walking legs are long, strong and contain numerous long tactile setae especially on the ventral side and on the joint region (Figs. 8(A-H). All walking legs covered with trichobothria, contain slit sensilla and chemosensitive hairs. Each tarsus ends with two comb-like claws and scopulae between them.

Scopulate hairs are hairs accumulated on the tip of each tarsus below claws (Figs. 9(A, B&C). Each hair with many fine barbs along the entire hair shaft and thin spiky hairs (Fig. 9D).

Large tactile seta is long as corn-shaped and bears small barbs on lines. This seta inserted into a socket present on the ventral and lateral side of the region near the joint between tarsus and tibia in female pedipalps (Fig. 9E). At higher magnification the seta shaft exhibits regular, cuticular ridges that bear numerous small barbs (Fig.9F).This seta is present with plumose seta on the ventral side of tibia, the joint between tarsus and metatarsus and on the ventral side of femur in the fourth left leg (Figs. 9G &10(A&B)). This seta arranges around joint of tarsus and metatarsus in the fourth right leg and present on the ventral side of tarsus of the female pedipalp (Figs.10(C&D) and 11(A&B). This seta distributed between the chemosensitive hairs in the ventral side of metatarsus of the first left leg and present on the joint between tarsus and metatarsus of fourth right leg (Figs. 11C).

Plumose setae have a long narrow trunk, sharp at the apex and branched from both sides of the trunk. Lehtinen (1975a, b) suggested that this type of seta are bilateral and look like a feather and called a "feathery hair". Slit sensilla and short plumose seta are present on the dorsal side of tibia of the first right leg (Fig.11D). Large tactile seta with plumose seta is present on the ventral side of the femur in the fourth left leg and on the tibia of the first left leg (Fig. 11(E&F)). Large tactile seta may act as mechano and chemosensitive hairs.

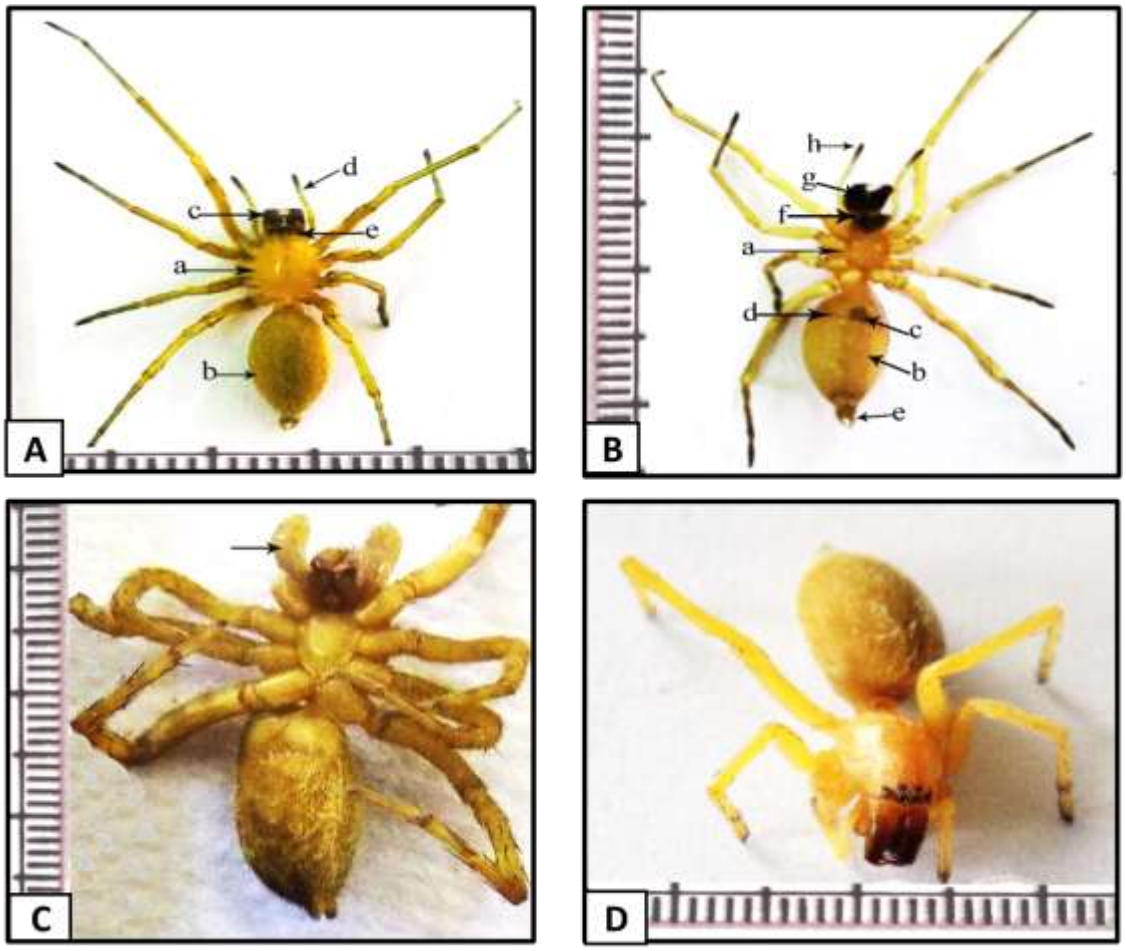

Figure 1. (A) Light photograph of the dorsal side of the adult female *Cheiracanthium isiacum.* a. prosoma. b. opisthosoma. c. chelicerae. d. female palpi. e. eyes. **(B)** Light photograph of the ventral side of the adult female *Cheiracanthium isiacum.* a. sternum. b. opisthosoma. c. epigynum. d. book lung slit. e. spinnerets. f. mouthparts. g. chelicerae. h. female pedipalp. **(C)** Light photograph oh the ventral side of adult female showing the female pedipalps (arrow). **(D)** Light photograph of the frontal side of the adult female. a. prosoma. b. eyes. c. chelicerae.

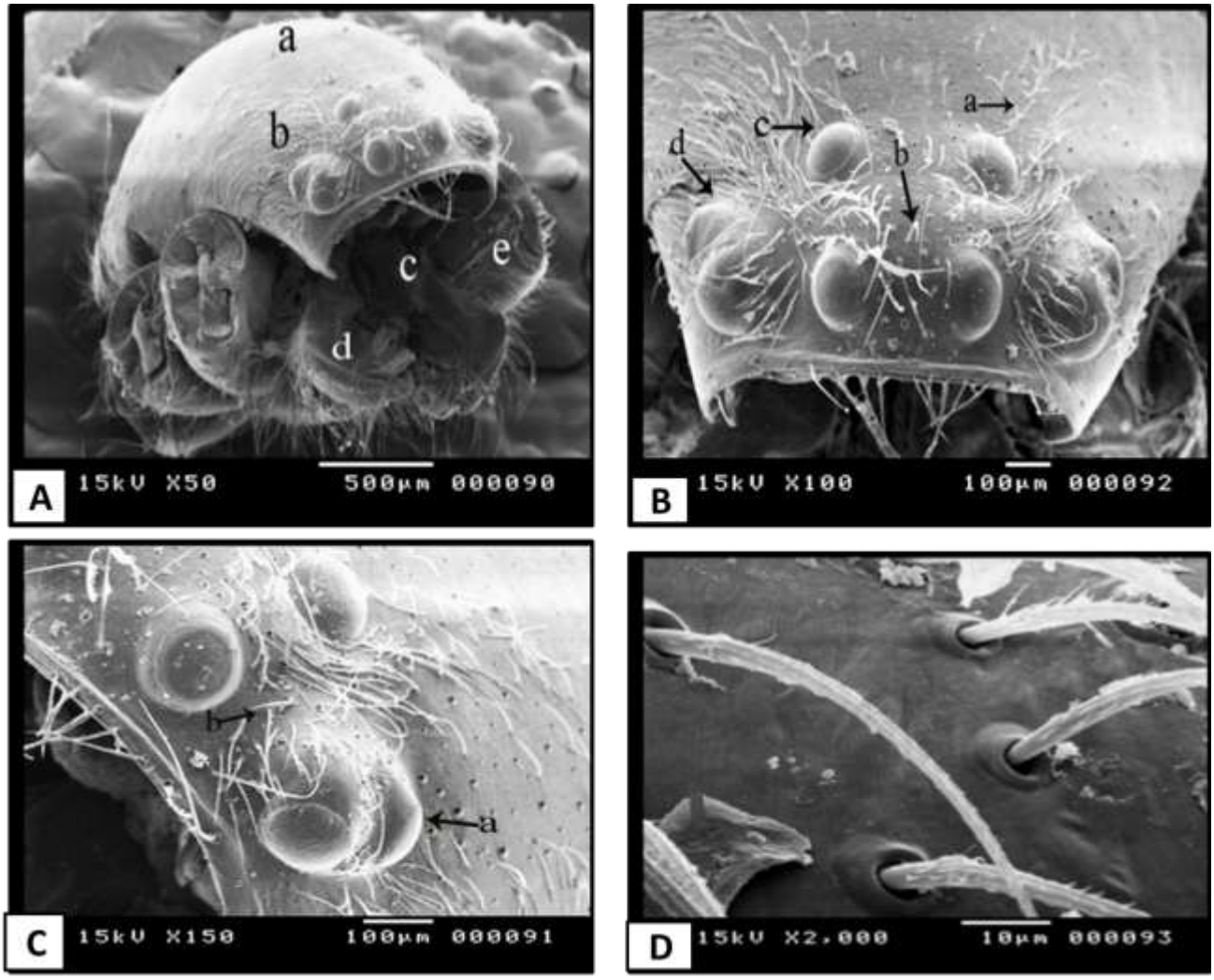

Figure 2. (A) Scanning electron micrograph (SEM) of the frontal distal end of the adult female showing: a. prosoma. b. lateral eyes. c. mouth opening. d. right maxilla. e. left maxilla. **(B)** SEM of the dorsal side of the distal end of prosoma showing: a. tactile sensory hairs. b. sensilla trichodea. c. postero-median eyes. d. lateral eyes. **(C)** SEM of the dorso-lateral side of the anterior-distal end of prosoma showing: a. lateral eyes. b. straight sensilla trichodea. **(D)** SEM of the dorsal side of prosoma showing: enlarged of the sensory tactile hairs.

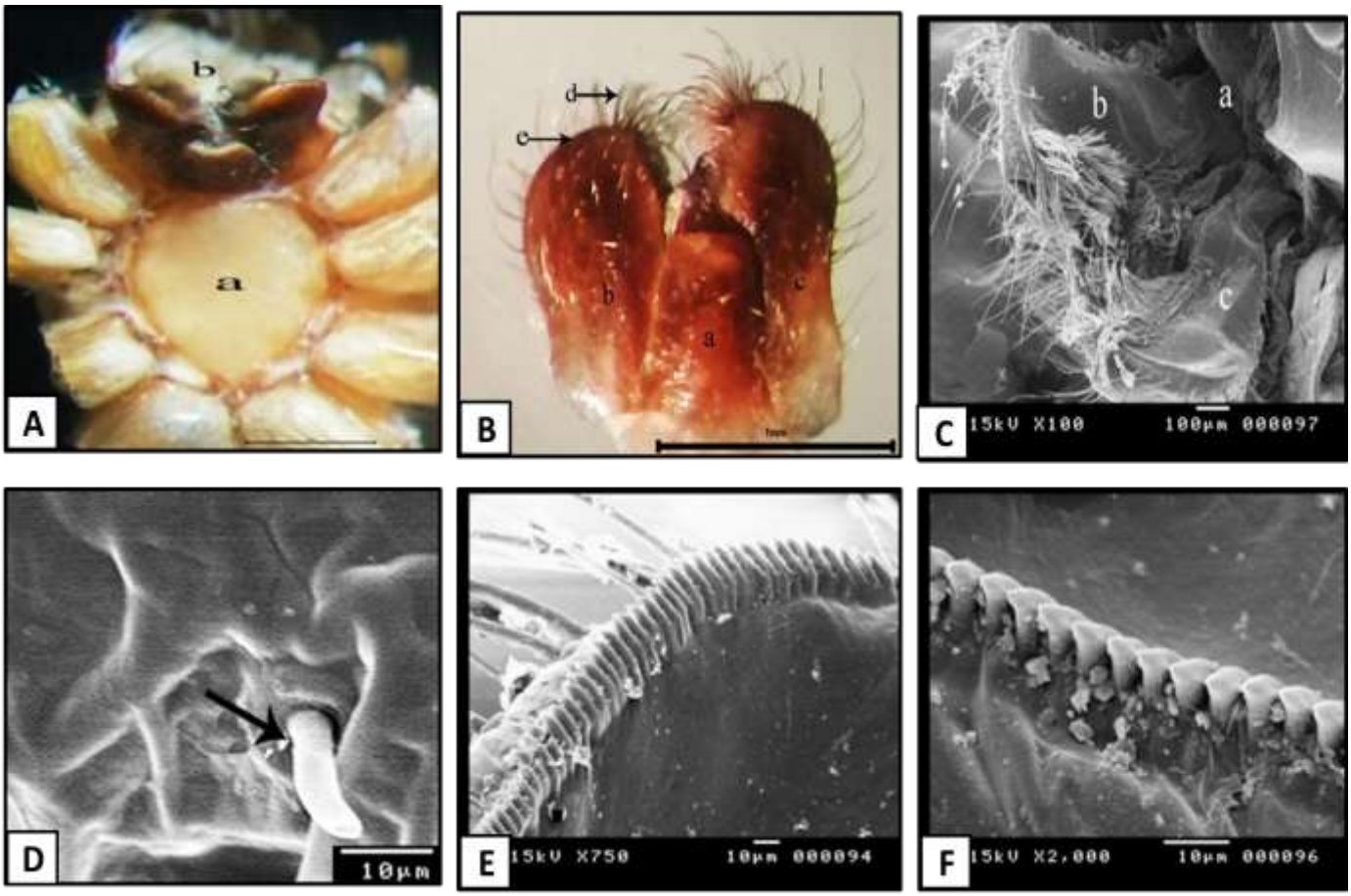

Figure 3. (A) Light photograph of the ventral side of the adult female showing: a. sternum. b. mouthparts. **(B)** Light photograph of the isolated dissected mouthparts of the adult female showing: a. labium. b. left maxilla. c. right maxilla. d. dense tactile sensory hairs. e. teeth. **(C)** SEM of the mouthparts of the adult female showing: a. mouth-opening. b. right maxilla. c. dense tactile taste hairs. **(D)** SEM of the ventral side of maxilla showing: the enlarged sensilla trichodea. **(E)** SEM of the interior side of maxilla showing: the serrate teeth. **(F)** SEM of the enlarged portion of maxilla showing: sharp teeth.

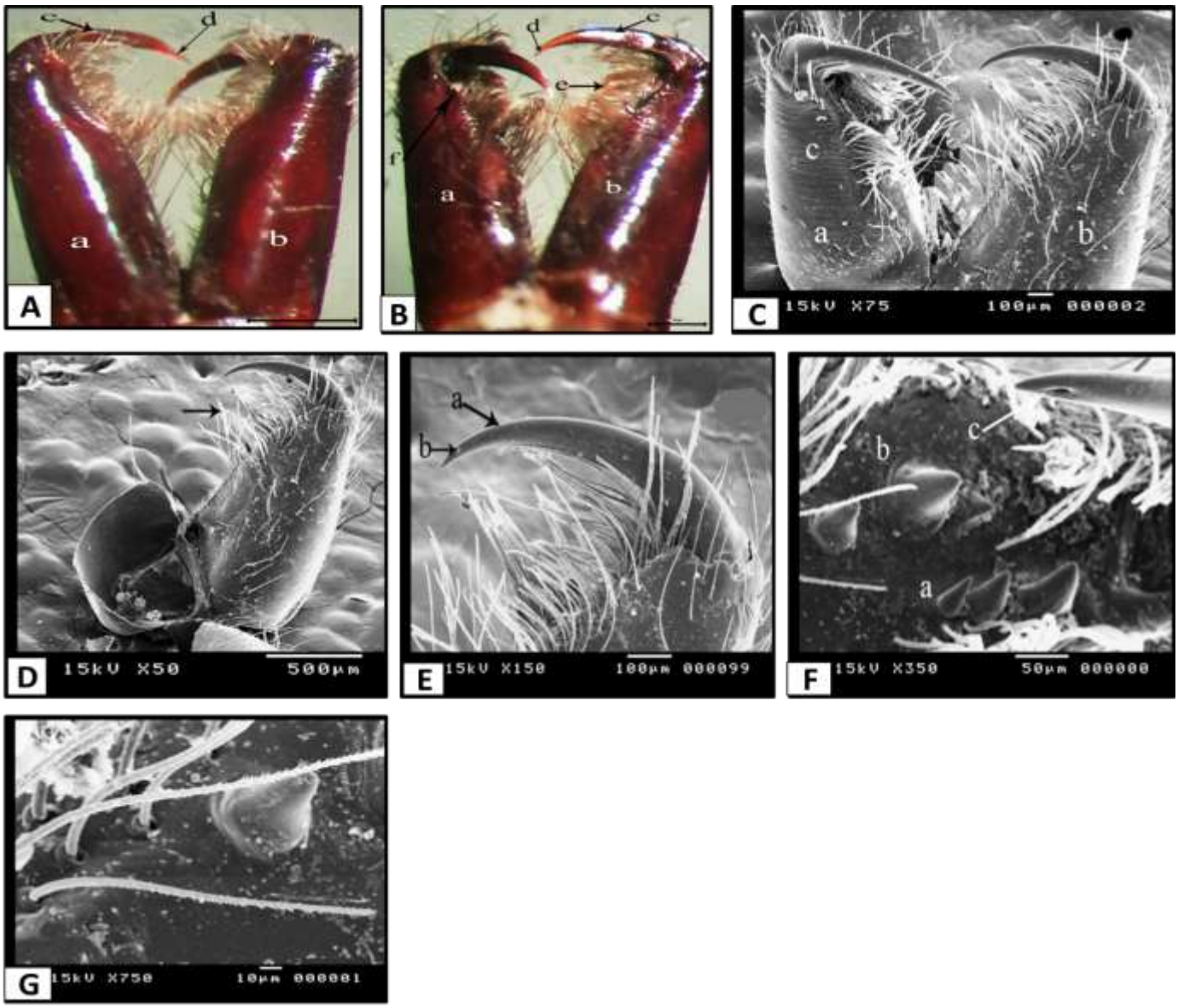

Figure 4. (A) Light photograph of the dorsal side of chelicerae of the adult female *Cheiracanthium isiacum*. a. right chelicera. b. left chelicera. c. fang. d. opening of venom gland. **(B)** Light photograph of the ventral side of chelicerae of the female .a. right chelicera. b. left chelicera. c. fang. d. opening of venom gland. e. dense tactile hairs. **(C)** SEM of the ventral side of chelicera of the female showing: a. right chelicera. b. left chelicera. c. female stridulatory ridges. **(D)** SEM of the ventral side of the left chelicera of the female showing the dense tactile taste hairs (arrow). **(E)** SEM of the distal end of chelicera of the female showing: a. fang. b. opening of venom gland. **(F)** SEM of the chelicera of the female showing: a. teeth of promargin. b. teeth of retromargin. c. tactile taste sensory hairs (chemoreceptors). (G) SEM of chelicera of the female showing the magnification of tactile taste sensory hairs (chemoreceptors).

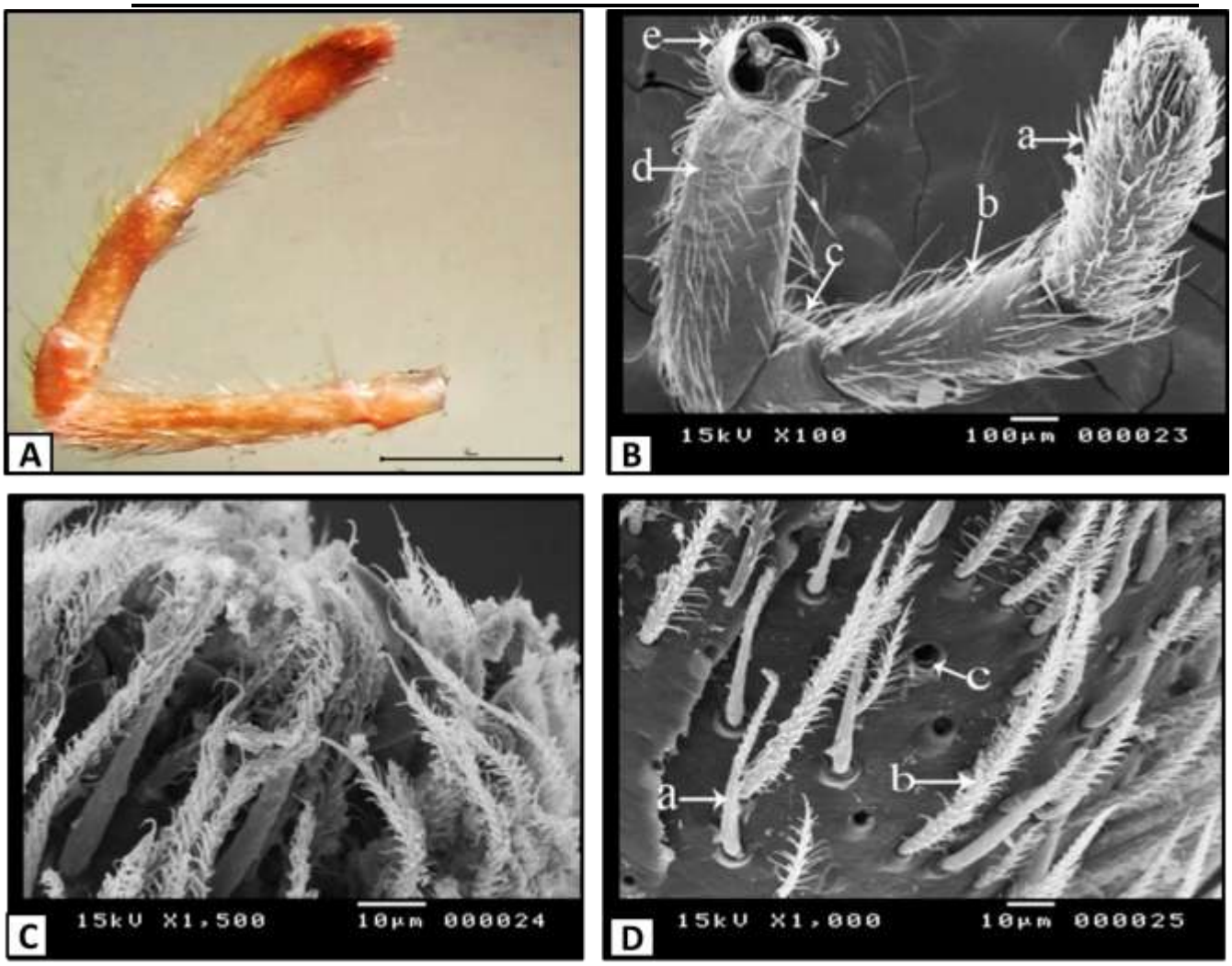

Figure 5. (A) Light photograph of the lateral side of the female pedipalp. **(B)** SEM of the ventral side of the female pedipalp showing: a. tarsus. b. tibia. c. patella. d. femur. e. trochanter. **(C)** SEM of the distal end of tarsus of the female pedipalp showing the dense scopulate hairs surrounded by the claws. **(D)** SEM of the dorsal side of tarsus behind the claws of the female pedipalp showing: a. chemosensitive hairs. b. thickened trichobothria. c. base of fallen thickened trichobothria.

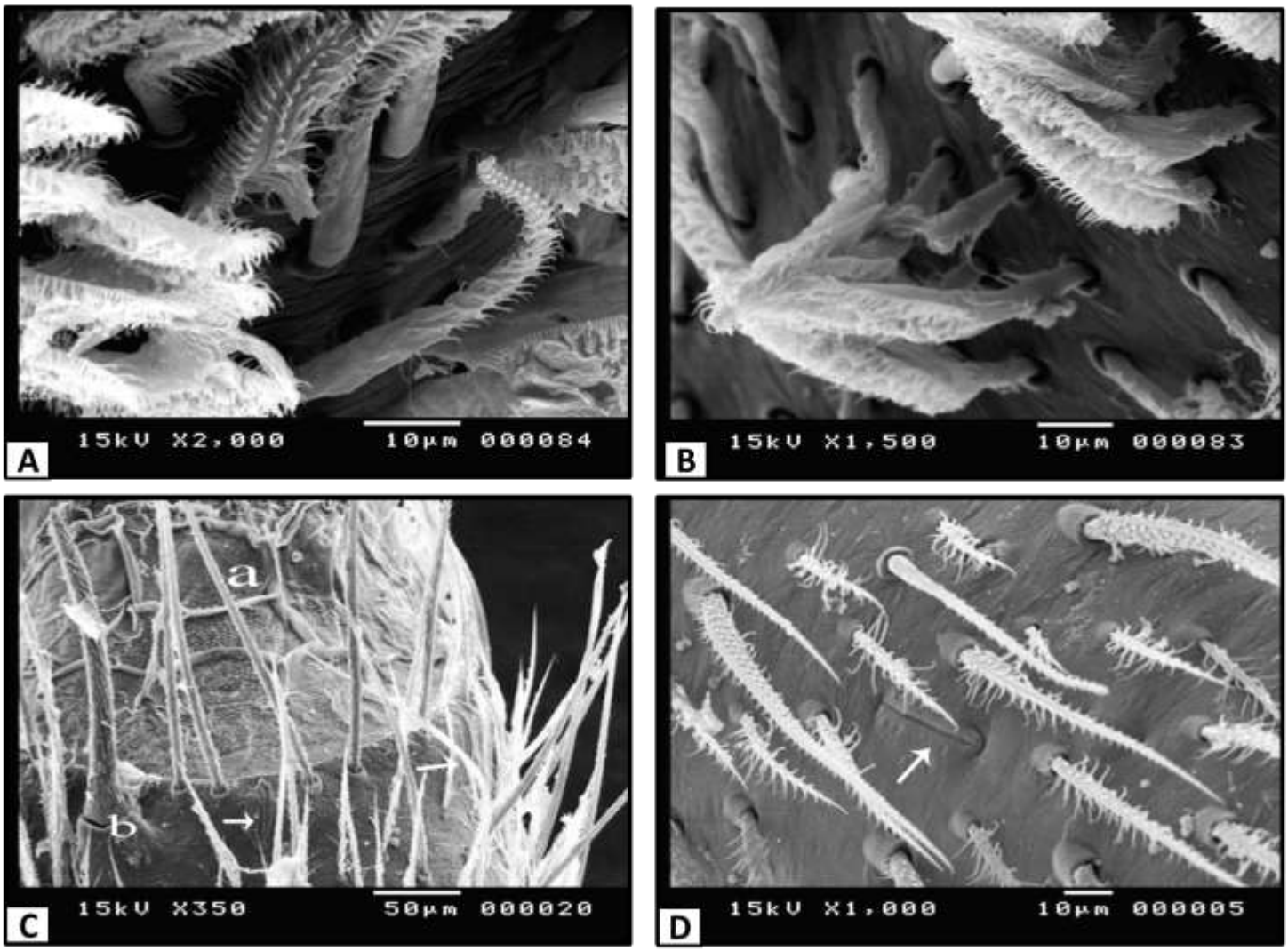

Figure 6. (A) SEM of the ventral side of tarsus below claws in the first right leg of the female showing: the chemosensitive hairs (are bent hairs which are smooth at the base but bears spiny extensions more distally and the hair tip is blunt). **(B)** SEM of the ventral side of the tarsus in the first right leg of the female showing: the accumulation of the chemosensitive hairs. **(C)** SEM of the ventral side of joint between metatarsus and tibia in first left leg of the female showing: a. slit sensilla (Lyriform organ) (arrows). b. large tactile seta. **(D)** SEM of the ventral side of tibia of the fourth left leg of the female showing: slit sensilla between thickened trichobothria (arrow).

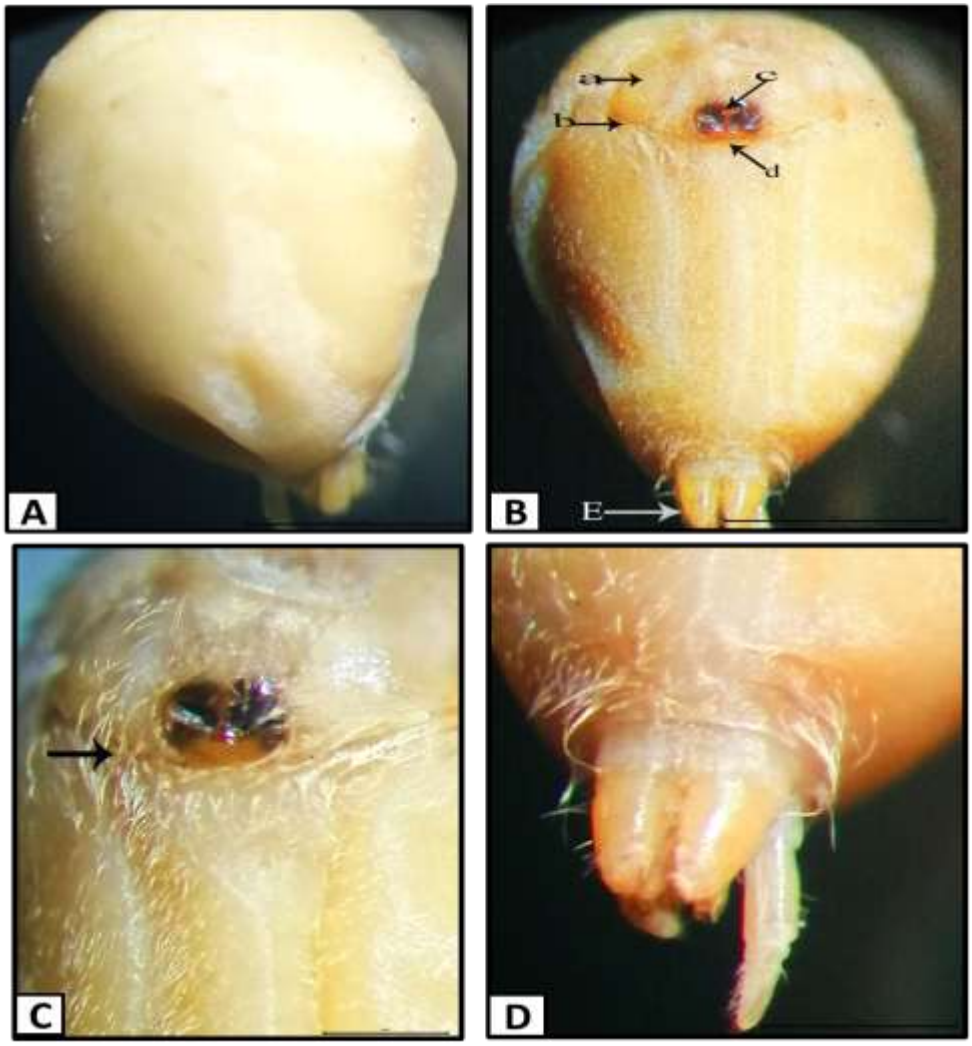

Figure 7. (A) Light photograph of the dorsal side of the opithosoma of adult female *Cheiracanthium isiacum.* **(B)** Light photograph of the ventral side of the opisthosoma. a. book lung cover. b. book lung slit. c. epigynum. d. epigastric furrow. **(C)** Light photograph of the ventral side of the opisthosoma of the female showing the epigynum. **(D)** Light photograph of the distal end of the opisthosoma showing the spinnerets.

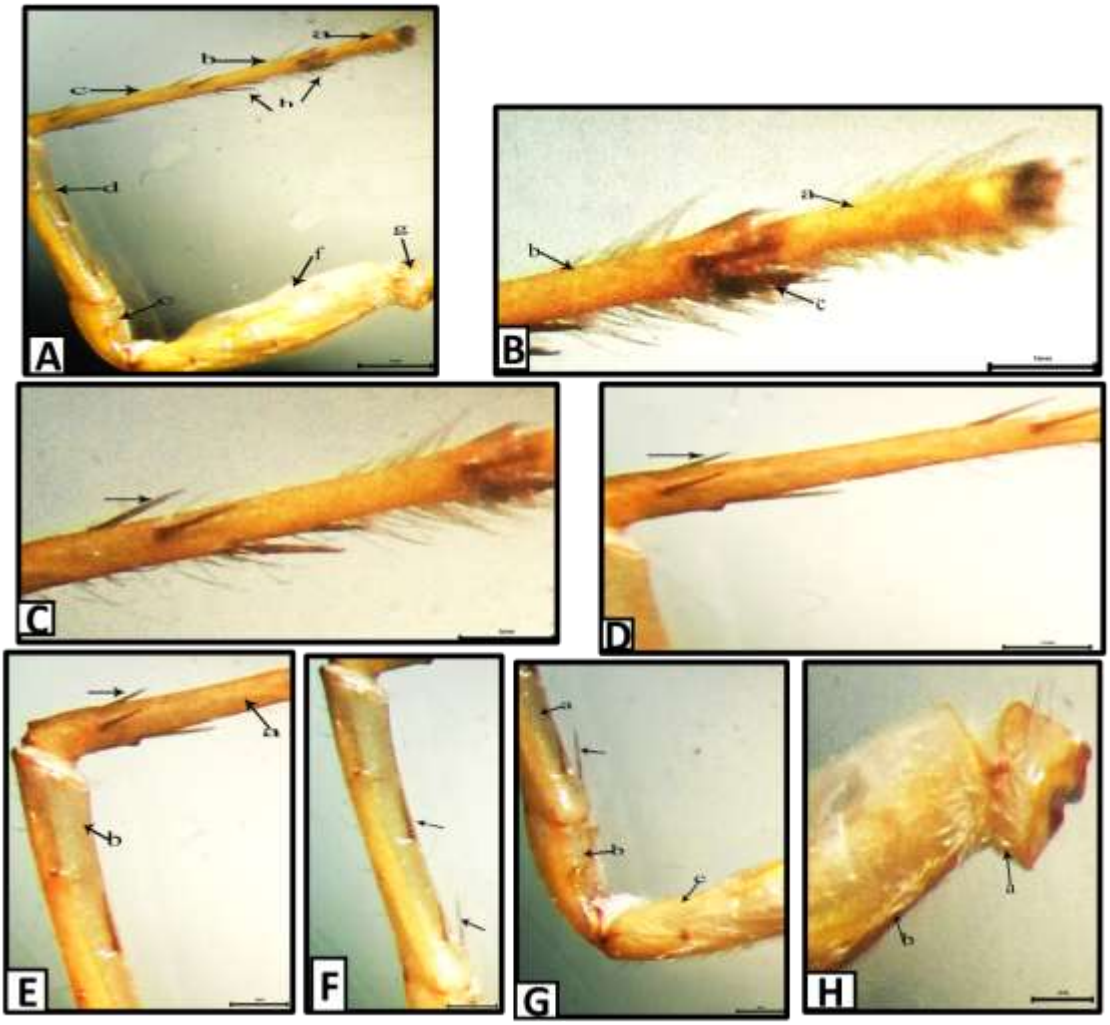

Figure 8. (A) Light photograph of the ventral side of the fourth right leg showing the distribution of the large tactile setae. a. tarsus. b. metatarsus. c. tibia. d. tibia. e. patella. f. femur. g. trochanter. **(B)** Light photograph of the ventral side of the joint between tarsus and metatarsus of the fourth right leg showing: a. tarsus. b. thickened trichobothria. c. large tactile setae. **(C)** Light photograph of the ventral side of metatarsus of the fourth left leg showing the large tactile setae in the middle region of metatarsus (arrow). **(D)** Light photograph of the ventral side of tibia of the fourth left leg showing the large tactile seta near the joint between tibia and patella (arrow). **(E)** Light photograph of the ventral side of the joint between metatarsus and tibia of the first right leg showing: a. metatarsus. b. tibia. The large tactile setae (arrow). **(F)** Light photograph of the ventral side of tibia of the first left leg showing distribution of large tactile setae (arrow). **(G)** Light photograph of the ventral side of the patella between tibia and femur of the fourth right leg showing: a. tibia. b. patella. c. femur. **(H)** Light photograph of the lateral side of the joint between femur and trochanter of the fourth left leg showing: a. trochanter. b. femur.

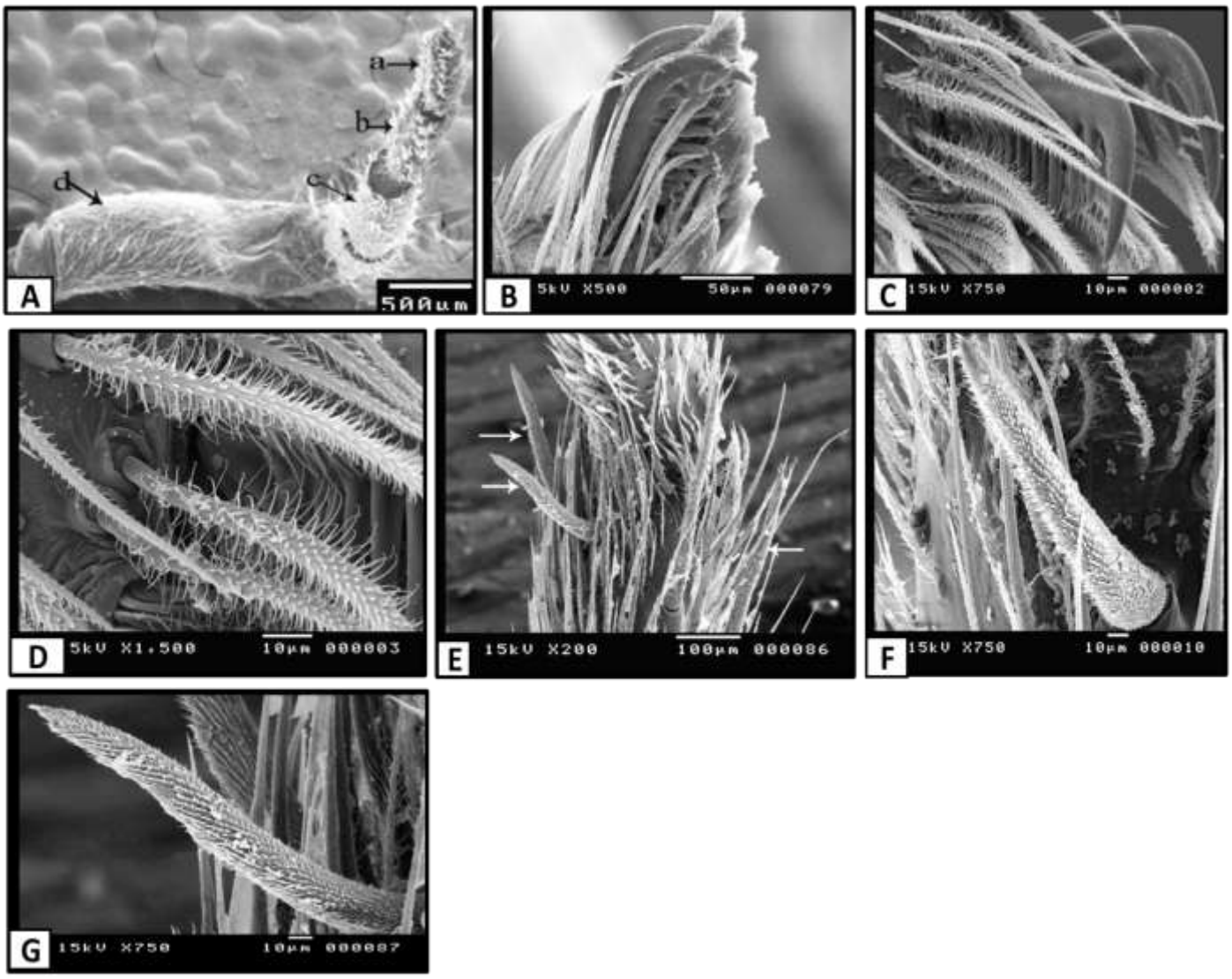

Figure 9. (A) Scanning electron micrograph (SEM) of the ventral side of the first right leg of the female *Cheiracanthium isiacum* showing: a. tarsus. b. metatarsus. c. tibia. d. femur. (**B)** SEM of lateral side of claws in tarsus in the first right leg of adult female *Cheiracanthium isiacum* showing: scopulate hairs around the claws. **(C)** SEM of lateral side of tarsus in fourth right leg of adult female showing: scopulate hairs. **(D)** SEM of distal end of tarsus in the first left leg showing: enlarged scopulate hairs. **(E)** SEM of the ventral side of the joint between tarsus and metatarsus of fourth right leg showing: the large tactile setae (arrows). **(F)** SEM of the ventral side of metatarsus of the fourth right leg showing: enlarged large tactile setae. **(G)** SEM of the ventral side of the joint between tarsus and metatarsus of fourth left leg showing: the enlarged large tactile setae.

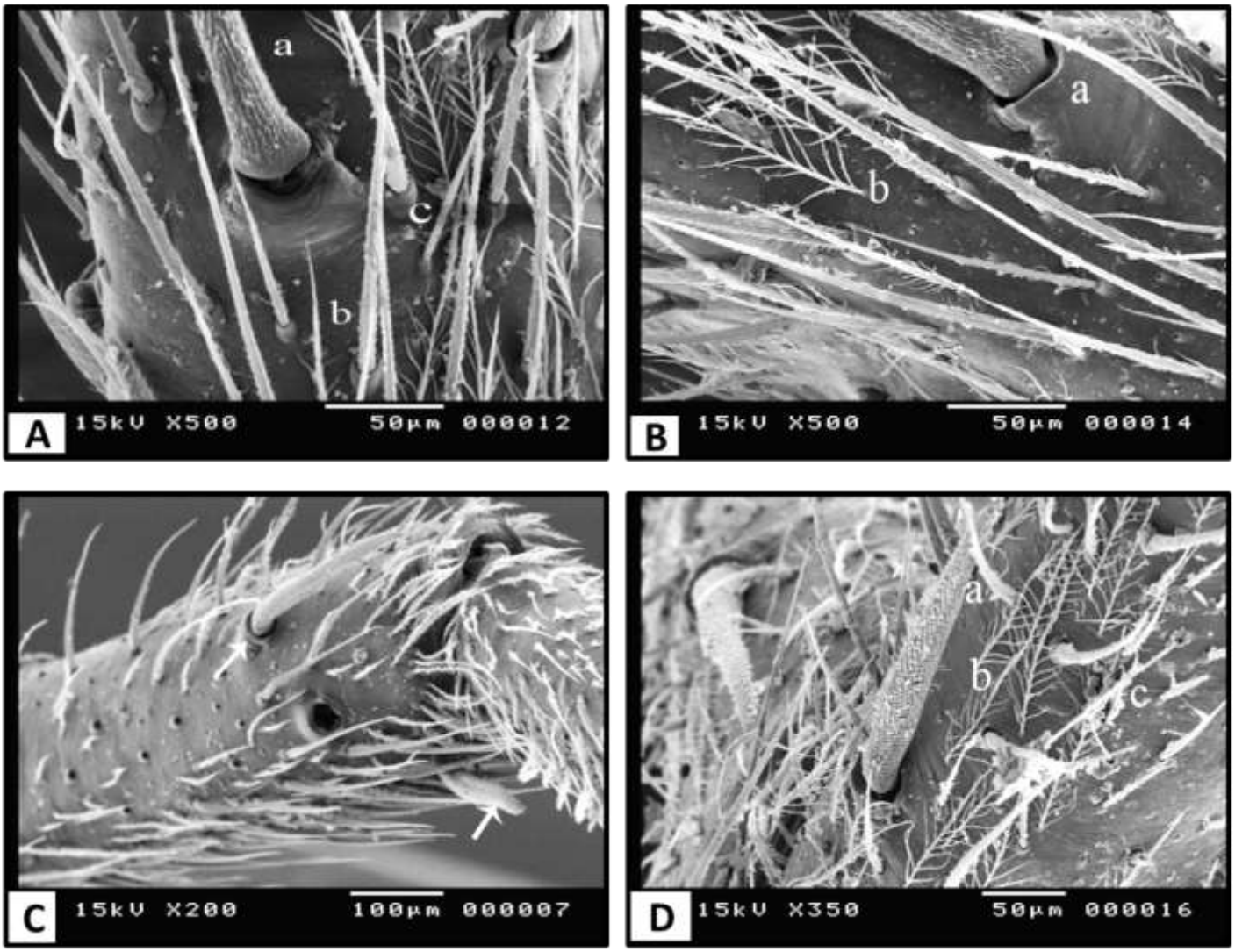

Figure 10. (A) SEM of the ventral side of the joint between tarsus and metatarsus in the fourth left leg showing: a. large tactile seta. b. thickened trichobothria. c. plumose setae. **(B)** SEM of the ventral side of tibia in fourth left leg showing: a. large tactile seta. b. plumose seta. **(I)** SEM of the ventral side of femur in the fourth left leg showing: plumose seta. **(C)** SEM of the Ventro-lateral side of the joint between tarsus and metatarsus in fourth right leg showing: arrangement of large tactile seta around the joint. **(D)** SEM of the ventral side of femur in the fourth left leg showing: a. large tactile seta. b. Plumose seta. c. small thickened trichobothria.

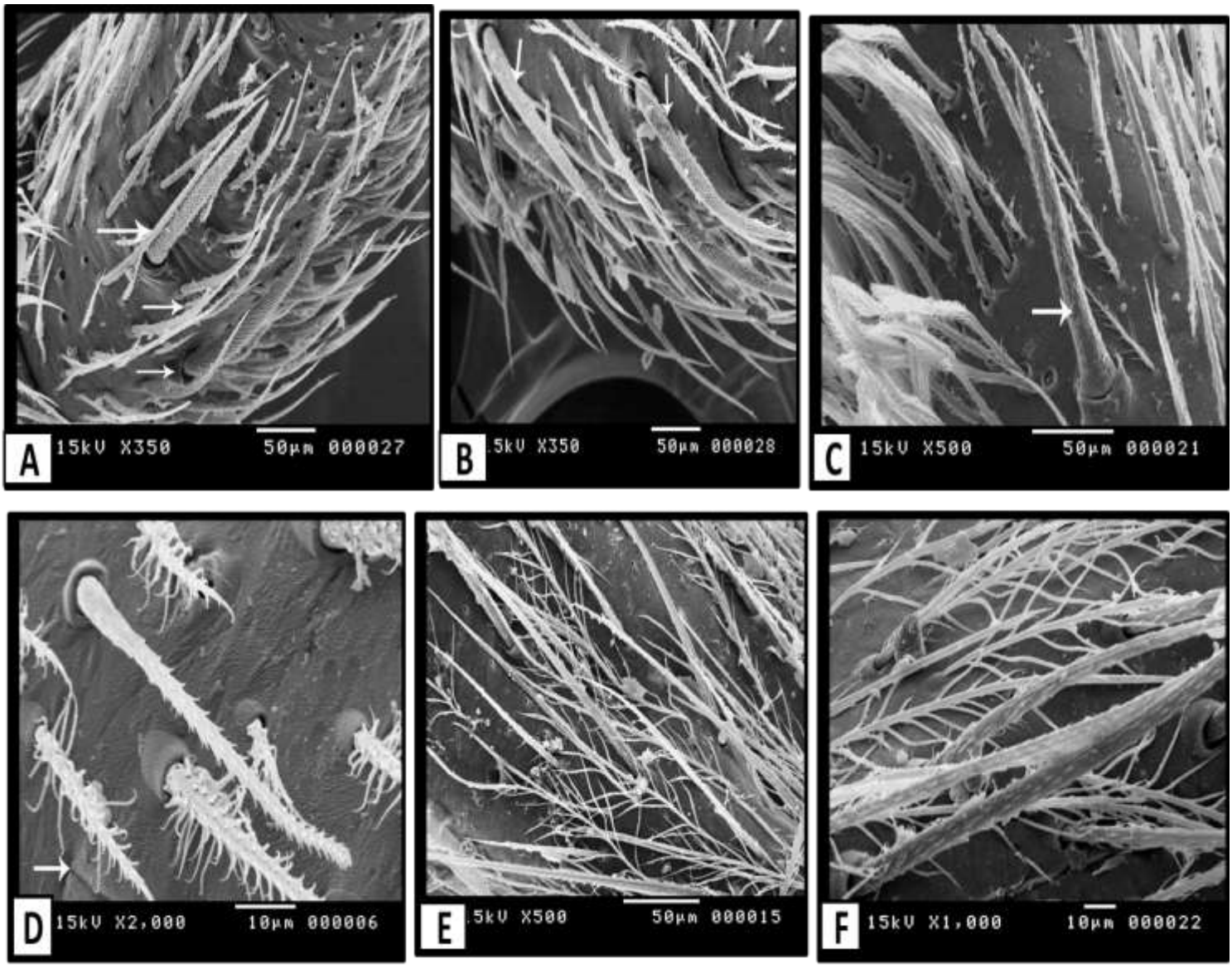

Figure 11. (A) SEM of the ventral side of tarsus of the female pedipalp showing: the large tactile seta (arrows). **(B)** SEM of the dorsal side of the joint between tarsus and tibia of the female pedipalp showing: the large tactile setae (arrows). **(C)** SEM of the ventral side of metatarsus in the first left leg showing : the large tactile seta (arrow) between the chemosensitive hairs. **(D)** SEM of the dorsal side of tibia in the first right leg showing the slit sensilla (arrow) and short plumose seta. **(E)** SEM of the ventral side of femur in the fourth left leg showing: the plumose setae. **(F)** SEM of the ventral side of tibia in the first left leg showing: a. plumose seta. b. thickened trichobothria.

DISCUSSION

Eyes are eight blacked located on the frontal side of prosoma, arranged in two slightly parallel transverse straight rows. This result concerning the size and arrangement of anterior median eyes is in accordance with (30, 31).

Sensilla trichodea are present on the dorsal surface of prosoma. Enlarged tactile sensory hairs show that these hairs bear small barbs and long tapering end. Scientists suggested that sensilla trichodea may serve as detecting odor (32). (33) indicated that sensillum trichodea is numerous on the antenna of the insect *Ostrinig nubilalis*. (34) suggested that trichoid sensilla might act as determine distance from an odor source for olfaction and gustation.

Mouthparts of *Cheiracanthium isiacum* consists of two maxilla and labium between them Below labium and maxilla, tiny sensory hairs are present which may act as chemosensory receptors. (35) found twelve trichoid sensilla on the dorsal surface of the labrum of the noctuid, *Spodoptera exigua*. The promargins of the endites are fringed with dense tactile taste hairs which may use to filter the liquefied food. There are dense tactile taste hairs accumulated on the maxilla and labium. The curved trichoid sensilla with many tiny sensory hairs on each maxilla are present. (36) indicated that when the mandibles are closed, the sensilla trichodea lean against the mandible's outer surface. They also suggested that the sensilla trichodea serve as mechanoreceptors, responding to the movement of the mandibles.

Female stridulatory ridges on chelicera are present on the ventral side of distal latreral ends of female chelicera. Dense tactile taste sensory hairs accumulated around fangs and teeth. Teeth are found on two fangs furrow. Cheliceral teeth are important as taxonomic characteristics for taxonomists. These results agree with (37) and (11). There are various numbers of different lengths and thickness of tactile sensory hairs on dorsal and ventral side of chelicerae. These tactile hairs may act as chemoreceptors and mechanoreceptors according to (19).

Thickened trichobothria with different length, blunt tip and large prominent sockets are present on the dorsal and ventral side of female chelicerae, pedipalps and all walking legs. (38) observed that trichobothria were deflected by the sound of a violin and therefore called them Hörhaare (hairs of hearing). (39) indicated that trichobothria are present on all parts of legs and pedipalps of all spiders. (40) suggested that the trichobothria on the pedipalps respond to the pheromone and the arrangement may serve as gravity receptor as proposed for crickets (41) and as substrate vibration detectors in trap-door spiders. (42) and (38) reported that trichobothria are sound detectors but they can also detect substrate vibrations. (41) stated that the arrangement of trichobothria may act as gravity receptor, as proposed for crickets, for which clavate trichobothria act as gravity sense organ. (43) stated that trichobothria in scorpions used in anemotactic

orientation and for the location of prey (Krapf on Androctonus and Buthus, personal communication). (32) suggested that the spiders that live on solid ground can use these sensilla both for releasing flight and predatory behavior. The chemosensitive hairs has a bent hair shaft which is smooth at the base but bears spiny extensions more distally and the hair tip is blunt and exhibits a small pore. These results agree with (44). Slit sensilla are present singly in loose groups and in tight groups and called lyriform organ. They are present on the ventral side of the joint between the metatarsus and tibia in the fourth left and right walking legs and on the ventral side of tibia of the fourth left leg. (45) stated that slit sensillae have a very important role in detecting vibrations from prey with their sensitivity they detect vibrations in many different media for example, sand, water and plants. (46) suggested that arachnid slit sensilla serves as mechanoreceptors which respond to a stresses in the exoskeleton caused by external vibration. Scopulate hairs are hairs accumulated on the tip of each tarsus below claws. Each hair with many fine barbs along the entire hair shaft and thin spiky hairs. These results agree with (31). These hairs may use for locomotory purposes, according to (47) and (48). (44) pointed that these hairs are used in prey capture by giving the spiders a good grip on large struggling prey. With the aid of the distal-most hair pad (claw tuft), spiders can move surefootedly on smooth, vertical surfaces (49, 50). (51) suggested that, the structure of these scopulate hairs is very similar to known contact chemoreceptors in arthropods, especially in spiders. Large tactile seta is long as corn-shaped and bears small barbs on lines. These results agrr with (52). Large tactile seta may act as mechano and chemosensitive function according to (52) and (44) Plumose setae have a long narrow trunk, sharp at the apex and branched from both sides of the trunk. (52, 53) suggested that this type of seta are bilateral and look like a feather and called a “feathery hair”.

CONCLUSION

Spiders like that of all animals their behavior is controlled by the central nervous system. Sensory systems are an organism’s windows to any surrounding stimuli in a very limited sense. Sense organs reflect the effect of the stimuli; they are help spiders to identify the prey and the enemies. The spiders differ from the vertebrates in which, spiders have eight eyes, they don`t have ears or noses but all parts of spiders cover with different types of hairs and contain various numbers of sensory organs. Hairs may act as mechano-or chemo-receptors functions and they can detect any stimuli on the surrounding environments. The aim of the present study is to elucidate the morphology of the different sensory organs on all parts of the body of adult *Cheiracanthium isiacum*. These species belonging to family: Cheiracanthiidae which known as black-footed yellow sac. Scanning electron microscope study revealed the presence of different types of sensillae and hairs such as; trichodea, sensilla basiconica, sensilla placodea, slit sense organs, tactile hairs, trichobothria, scales, large tactile setae and chemosensitive hairs.

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