



Taxonomic studies on the genus *Calliphora* robineau-desvoidy (Diptera: Calliphoridae) from India

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Abstract

Four Indian species belonging to the genus *Calliphora* Robineau-Desvoidy have been studied and detailed descriptions have been written for each of them that include synonymy, morphological attributes, colouration, chaetotaxy, wing venation, illustrations of male and female genitalia, material examined, distribution, holotype depository and remarks. A key to the Indian species has also been provided.

Keywords: India, *Calliphora*, calliphorinae, calliphoridae, diptera

Introduction

The genus *Calliphora* Robineau-Desvoidy is represented by four species in India (Bharti, 2011) [2]. They are medium to large sized flies commonly called the blue bottles. The diagnostic characters of the genus include: eyes holoptic or subholoptic in male, dichoptic in female; jowls about half eye height; facial carina absent; length of 3rd antennal segment less than 4X that of 2nd; arista long plumose; propleuron and prosternum hairy; postalar declivity hairy; acrostichals 1-3+3; dorsocentrals 2-3+3; pre-intra-alars present; presutural present; humerals 4; posthumerals 3; supra-alars 3-5; postalars 2; notopleurals 2; lateroscutellars 3-5; apicoscutellar and discoscutellar 1 each; sternopleurals 2+1; wings hyaline, slightly infuscated anteriorly and basally; R1 bare, R4+5 with fine setae; first posterior cell (R5) open; basicosta and epaulet brown to black; subcostal sclerite with cilia; thoracic squama with fine hair dorsally; abdomen dark blue with metallic lustre and grey dusted; tergites 3 and 4 with marginal bristles; sternite 5 with deep incision posteriorly.

i) *Calliphora vicina* Robineau-Desvoidy, 1830 (Figs. 1-7)

- *Musca carnivore* Fabricius, 1794. *Ent. Syst.*, 4: 313.
- *Musca erythrocephala* Meigen, 1826. *Syst. Beschi*, 5: 62 (preocc.).
- *Calliphora vicina* Robineau-Desvoidy, 1830. *Essai. Myod.*, 1830: 435
- *Calliphora lettoralis* Robineau-Desvoidy, 1830. *Essai Myod.*, 1830: 435.
- *Calliphora nana* Robineau-Desvoidy, 1830. *Essai. Myod.*, 1830: 435.
- *Calliphora monspeliaca* Robineau-Desvoidy, 1830. *Essi Myod.*, 1830: 435.
- *Calliphora musca* Robineau-Desvoidy, 1830. *Essai, Myod.*, 1830: 435.
- *Calliphora spitzbergensis* Robineau-Desvoidy, 1830. *Essai. Myod.*, 1830: 435.
- *Calliphora scutellata* Macquart, 1834. *Mem. Soc. Roy. Sci. Art Lille*, 1833: 161.

- *Calliphora rufifacies* Macquart, 1851. *Dipt. Exot. Suppl.*, 4: 216.
- *Musca aucta* Walker, 1853. *Insect. Saund. Dipt.*, 1: 334.
- *Calliphora insidiosa* Robineau-Desvoidy, 1863 *Insect. Saund. Dipt.*, 1: 334.
- *Calliphora insidiosa* Robineau-Desvoidy, 1863. *Posth.* 2: 695.
- *Calliphora turanica* Rohdeau-Desvoidy, 1863. *Posth.*, 2: 695.
- *Calliphora turanica* Rohdendorf, 1926. *Zool. Zn.*, 6: 90.
- *Calliphora vicina* Robineau Desvoidy: *Hall*, 1948. *Blowfl. North Amer.*: 307p.

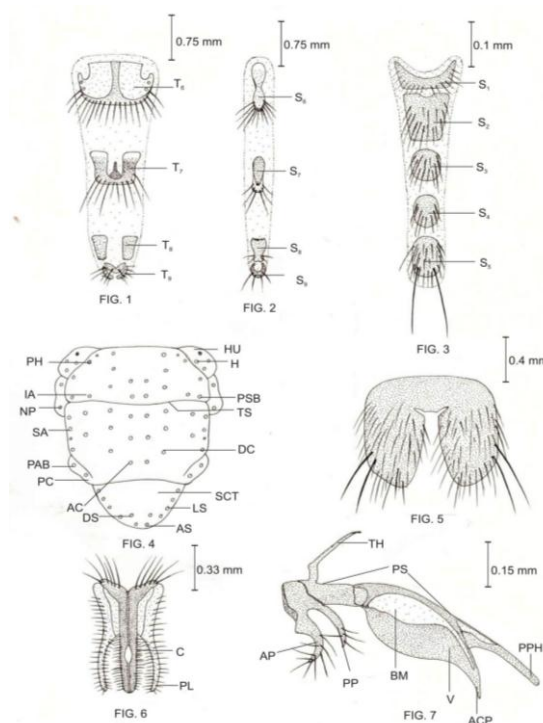


Fig 1-7: *Calliphora vicina*

Male

Body length 6.0-11.0mm.

Head

Eyes bare, subholoptic, facets uniform; frons dark brown, bare, narrow as it approaches vertex; parafrontalia black with golden to silver tomentum; frontal bristles well developed; fronto-orbital bristles present; ocellus with weak ocellar bristles and strong postvertical bristles; vertical bristles present, prevertical and outervertical bristles absent; parafacialia dark grey with golden tomentum, with fine hair; face blackish grey, bare; facial carina absent; epistome dark brown; medianae reddish brown, bare; jowls and genae reddish brown with black hair; postgenae reddish brown with brownish hair; vibrissae just above oral margin; peristomal bristles well developed; postorbit black with silver tomentum, bare; occiput grey with numerous yellowish white hair; antennae dark brown except base of 3rd segment which is orange, 1st and 2nd segments setulose with a long bristle on 2nd, length of 3rd segment about 3X that of 2nd; arista brown, long, plumose; palpi orange, slender with bristles present all over.

Thorax

Bluish black with dull silvery tomentum; humerus and postalar callus concolorous with dorsum; prothoracic spiracle brown; propleuron and prosternum covered with fine black hair; postalar declivity hairy; supraspiracular convexity bare; suprasquamal ridge bare.

Chaetotaxy (Fig. 4): Acrostichals 2+3; dorsocentrals 3+3; intra-alars 10+; presutural present; humerals 4; posthumerals 3; supra-alars 4; post-alars 2; notopleurals 2; latero-scutellars 4; apicosutellar and discoscutellar 1 each; sternopleurals 2+1; propleural and prostigmatic present.

Wings

Hyaline slightly infuscated anteriorly; veins dark brown; stem vein (R) bare; R₁ bare; R₄₊₅ with several short setae on both dorsal and ventral sides of basal node; first posterior cell (R5) open; epaulet and basicosta dark brown; subcostal sclerite brown with yellowish white cilia; alar squama light brown, bare; thoracic squama dark brown with numerous black hair on dorsal surface; halteres brown.

Legs

Black except tibiae brown; fore- and hindfemora with bristles on both dorsal and ventral sides while midfemur with bristles on ventral side only; foretibia with 1 bristle at middle and 3 at apex; midtibia with 2 bristles at middle and 3 at apex; hindtibia with 1 bristle at base, 2 at middle and 3 at apex.

Abdomen

Dark dull blue with some patches of grey dusting; tergite 2 darker than others and with weak marginal bristles; tergites 3-5 with well developed marginal bristles; sternites 1-5 with numerous black hair; sternite 5 with deep incision posteriorly; hypopygium conspicuous.

Male Genitalia

Fifth sternite (Fig. 5), Cerci and parolobi (Fig. 6), Aedeagus and parameres (Fig. 7).

Female

Body length 6.0-13.5mm. Similar to male except: eyes dichoptic, frons a little wider, fronto-orbital bristles present, legs with more bristles than in male. Sternites 1-5 (Fig. 3).

Female genitalia

Dorsal view of ovipositor (Fig. 1), Ventral view of ovipositor (Fig. 2)

Material examined

Chandigarh: 300M (11♂♂, 1♀) 1.X.199. Haryana: Kalka-370M (2♂♂, 6♀♀) 3.X.1999. Himachal Pradesh: Shimla-2208M (42♂♂, 19♀♀) 25-28.IX. 1999, 8-9.X.1999; Dalhousie-2036M (7♂♂, 9♀♀) 18.IX.2000; Kothi-2530M (25♂♂, 3♀♀) 16.VI. 2001; Marhi-3000M (2♂♂, 1♀) 7.VII. 2001. Punjab: Patiala-3000M (29♂♂, 3♀♀) 12.III.1992; Ropar-350M (7♂♂, 2♀♀) 21.III.2000. Uttarakhand: Kalsi-850M (2♂♂, 3♀♀) 27.V.2000; Purola-1524M (6♂♂, 11♀♀) 30.V.2000; Mussoorie-2005M (17♀♀) 8.VII.2001; Kalamunitop-2700M (32♂♂) 8.IX.2001. Coll. Inderpal Singh Sidhu.

Distribution

India (Chandigarh, Haryana, Himachal Pradesh, Punjab, Uttarakhand, Sikkim, West Bengal), Egypt, Europe, china, Japan, Mongolia, Saudi Arabia, South Africa, Australia, New Zealand and Nearctic region.

Holotype depository

USNM, Washington, USA.

Remarks

This species is widely distributed in the Oriental, Australian, Palaearctic and Nearctic regions. They are usually found in urban/suburban areas and enter houses during the cooler seasons (Anderson, 1995). Adults breed in dead decaying organic matter including carrion and excreta. It is typically a winter fly not available in the plains during hot summer months. It is a very good forensic indicator and has been put to this use in several cases (Greenberg, 1985; Smith, 1986; Catts and Haskel, 1990; Lord *et al.*, 1992; Nolte *et al.*, 1992). From all the other Indian species of *Calliphora* it can easily be differentiated on the basis of reddish brown medianae, jowls, genae and postgenae.

ii) *Calliphora vomitoria* (Linnaeus, 1758) (Figs. 8-14)

- *Musca vomitoria* Linnaeus, 1758. *Ent. Carn.*, 1763:325, 868.
- *Musca caerulea* De Geer, 1776. *Mem. Hist. Inst.*, 6:57.
- *Musca carnivora* Fabricius, 1794. *Ent. Syst.*, 4: 313.
- *Musca obscoena* Escholtz, 1822. *Entomograph*, 1822: 113.
- *Calliphora fulvibarbis* Robineau-Desvoidy, 1830. *Essai Myod.*, 1830: 434.
- *Calliphora brunibarbis* Robineau-Desvoidy, 1830. *Essai Myod.*, 1830: 434.
- *Calliphora vomitoria* (Linnaeus): Robineau-Desvoidy, 1830. *Essai Myod.*, 1830: 435.
- *Calliphora erythrocephala* Macquart, 1834. *Mem. Soc. Roy. Sci. Arts Lille*, 1833: 160.
- *Calliphora afinis* Macquart, 1835. *Suit. Buff.*, 2: 263.

- *Calliphora croceipalpis* Jaenicke, 1867. *Abh. Senckenb. Ges.*, 4: 376.
- *Calliphora antarctica* Schiner, 1868. *Nov. Reise*, 1868: 308.
- *Calliphora capensis* Brauer and Bergenstamm, 1891. *Denkschr. Akad. Wiss. Wien.*, 8: 442.
- *Calliphora loewi* Enderlein, 1903. *D. Tiefsee. Exp.*, 3: 254.
- *Calliphora rubifrons* Townsend, 1908. *Smith. Misc. Coll.*, 51: 116.
- *Calliphora vomitoria* (Linnaeus): *Ho*, 1936. *Chin. J.Zool.*, 2: 133.

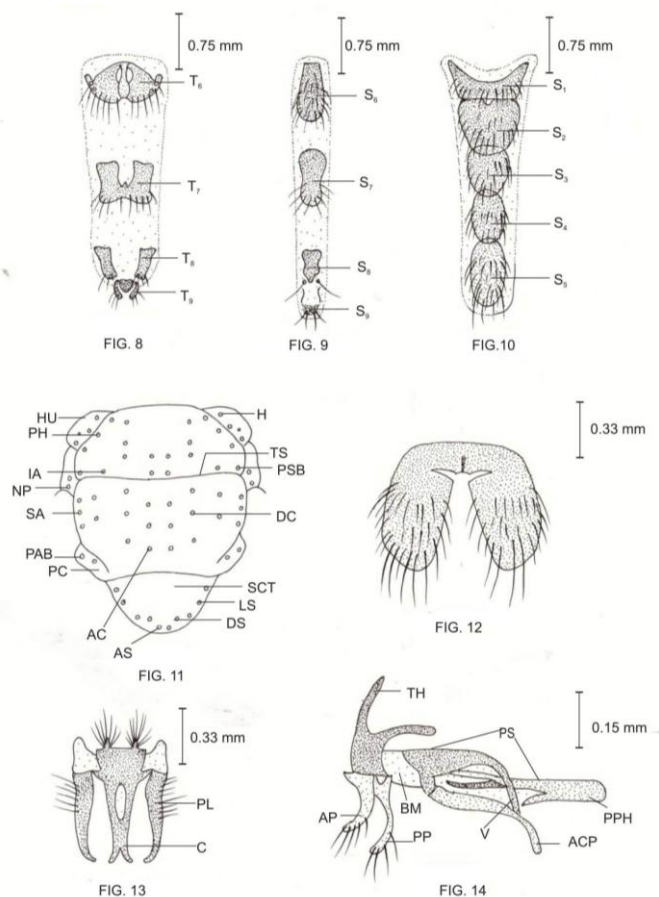


Fig 8-14: *Calliphora vomitoria*

Male

Body length 8.0-11.2mm.

Head

Eyes bare, subholoptic, facets uniform; frons reddish brown, bare, triangle shaped, narrows as it approaches vertex; parafrontalia greyish black with fine hair; frontal bristles weak; fronto-orbital bristles absent; ocellus with weak ocellar and postvertical bristles; vertical bristles present, prevertical and outervertical bristles absent; parafacialia reddish brown, bare; face black, bare; facial carina absent; epistome yellowish brown; medianae black, bare; jowls, genae and postgenae yellowish with yellow and black hair, with silver dusting; vibrissae present just above oral margin; peristomal bristles well developed; postorbit grey with silver tomentum, bare; occiput greyish with grey hair all over; antennae dark brown

except base of 3rd segment reddish brown, 1st and 2nd segments setulose, 2nd with a long bristle, length of 3rd segment about 3X that of 2nd; arista dark brown, long plumose; palpi orange with bristles present all over.

Thorax

Black to dark blue with white dusting at anterior part; humerus and postalar callus concolorous with dorsum; prothoracic spiracle brown; propleuron hairy on upper part; prosternum hairy on posterior part; postalar declivity hairy; supraspiracular convexity bare; suprasquamal ridge with anterior tuft.

Chaetotaxy (Fig. 11): Acrostichals 2+3; dorsocentrals 3+3; intra-alars 1+2; presutural present; humerals 4; posthumerals 3; supra-alars 3; post-alars 2; notopleurals 2; lateroscutellars 3; apicoscutellar and discoscutellar 1 each; sternopleurals 2+1; propleural and prostigmatic present.

Wings

Hyaline, slightly infuscated at anterior margin and base; veins dark brown; stem vein (R) bare; R1 bare; R4+5 with several short setae on dorsal and ventral surface of basal node; first posterior cell (R5) open; epaulet and basicosta black; subcostal sclerite brown to orange with orange marginal cilia; alar and thoracic squamae dark brown, thoracic squama with numerous fine hair on dorsal surface; halteres brown.

Legs

black; fore- and hindfemora with bristles on both dorsal and ventral sides while midfemur with bristles on ventral side only; foretibia with 1 bristle at middle and 3 at apex; midtibia with 2 bristles at middle and 3 at apex; hindtibia with 2 bristles at apex.

Abdomen: Dark blue to green with purplish tinge and grey dusted; tergite 2 darker than others; tergites 3+5 with strong marginal bristles; sternites 1-5 with numerous black hair; sternite 5 with deep incision posteriorly; hypopygium conspicuous.

Male genitalia

Fifth sternite (Fig. 12), Cerci and paralobi (Fig. 13), Aedeagus and parameres (Fig. 14)

Female

Body length 8.0-13.0mm. Similar to the male except: eyes dischoptic, frons more wider, outervertical bristles absent, fronto-orbital bristles present. Sternites 1-5 (Fig. 10).

Female genitalia

Dorsal view of ovipositor (Fig. 8), Ventral view of ovipositor (Fig. 9).

Material examined

Himachal Pradesh: Koti-2355M (2♂♂, 2♀♀) 10.IX.2000; Dalhousie-2036M (3♂♂, 2♀♀) 18.IX.2000. Punjab: Dunera-640M (5♂♂, 4♀♀) 20.III.2000. Uttarakhand: Kalamunitop-2700M (1♂) 25.VI.1991; Yamunotri-3185M (1♂) 20.VI.1992, Coll. Dr. Devinder Singh; Munsayari-2290M ((2♂♂, 1♀) 17.X. 2001, Coll, Inderpal Singh Sidhu.

Distribution

India (Chandigarh, Himachal Pradesh, Punjab, Sikkim, Uttarakhand, West Bengal), Philippines, Taiwan, Afghanistan, China, Europe, Japan and North America.

Holotype depository

Not traceable.

Remarks

Having similar distribution like *C. vicina* Robineau-Desvoidy, this species is easily differentiated from the other species because of the presence of 3 supra-alars and 3 lateroscutellars. This species also favours shady areas (Mihalyi, 1965) and according to MacLeod and Donnelly (1957) it is more tropical than *C. vicina*. It is typically a saprophagous fly easily collected from decaying carrion.

iii) Calliphora pattoni Aubertin, 1931 (Figs. 15-21)

- *Calliphora aucta* Walker: Patton, 1922. *Bull. Ent. Res.*, 13: 113 (misident).
- *Calliphora pattoni* Aubertin, 1931. *Ann. Mag. Nat. Hist.*, (10)8: 615.

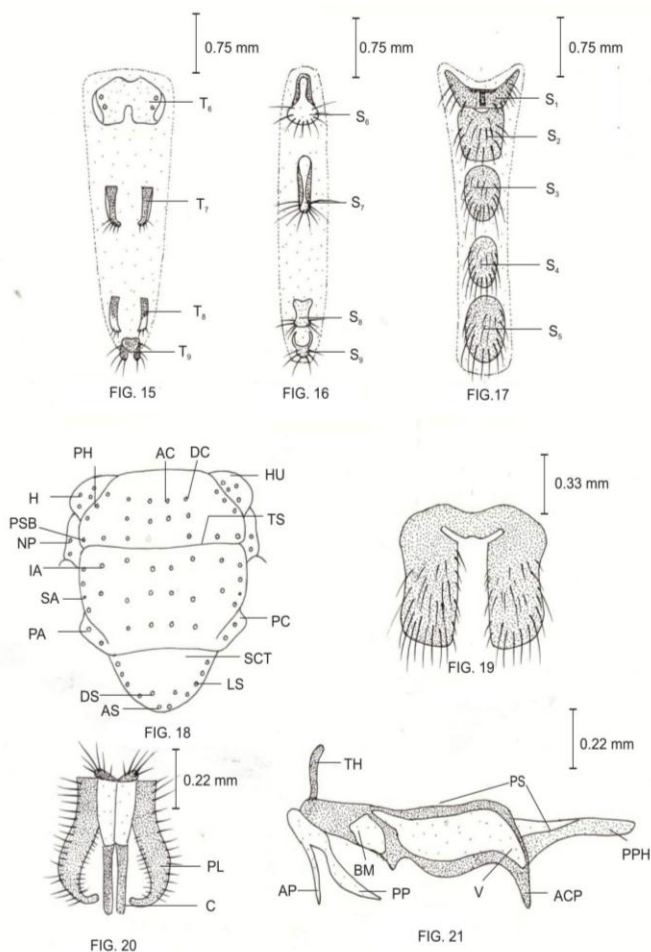


Fig 15-21: *Calliphora pattoni*

Male

Body length 7.5-10.2mm.

Head

Eyes bare, subholoptic, facets uniform; frons reddish brown, wider at base and narrows as it approaches vertex, hairy; parafrontalia narrower than frons, reddish brown with golden tomentum, hairy; frontal bristles well developed; fronto-orbital bristles absent; ocellus with weak ocellar bristles and strong postvertical bristles; vertical bristles present, prevertical and outer vertical bristles present, prevertical and outervertical bristles absent; parafacialia brown with golden tomentum, hairy; face black with golden tomentum, bare; facial carina absent, epistome brown; medianae black, bare; jowls, genae and postgenae black covered with black hair; vibrissae present well above oral margin; peristomal bristles well developed; postorbit covered with golden tomentum, bare; occiput greyish black covered with golden and black hair; antennae brown except base of 3rd segment orange; 1st and 2nd antennal segments setulose with long bristle on 2nd; length of 3rd segment about 3X that of 2nd; arista dark brown, long plumose; palpi orange with bristles present all over.

Thorax

Dull brownish black with patches of silver tomentum; humerus and postalar callus concolorous with dorsum; prothoracic spiracle black; propleuron and prosternum covered with fine black hair; postalar declivity hairy; supraspiracular convexity bare; suprasquamal ridge bare.

Chaetotaxy (Fig. 18): Acrostichals 2+3; dorsocentrals 3+3; intra-alars 1+2; presutural present; humerals 4; posthumeral 3; supra-alars 4; post-alars 2; notopleurals 2; lateroscutellars 4; apicoscutellar and discoscutellar 1 each; sternopleurals 2+1; propleural and prostigmatic present.

Wings

Hyaline; veins brown; stem vein (R) bare; R1 bare; R4+5 with several short setae on both dorsal and ventral sides of basal node; first posterior cell (R5) open; epaulet and basicosta dark brown; subcostal sclerite brown with yellowish white cilia; alar squama brown, bare; thoracic squama dark brown with numerous black hair on dorsal surface; halteres brown.

Legs

Black except tibiae brownish; fore- and hindfemora with bristles on both dorsal and ventral sides while midfemur with bristles on ventral side only; foretibia with 1 bristle at middle and 4 at apex; hindtibia with 2 bristles at base, 1 at middle and 2 at apex; hindtibia with 2 bristles at middle and 2 at apex.

Abdomen

Dull dark bluish black with slightly grey dusting; tergite 2 with weak marginal bristles while tergites 3-5 with well developed marginal bristles; sternites 1-5 with numerous black hair; sternite 5 with deep incision posteriorly, hypopygium conspicuous.

Male genitalia

Fifth sternite (Fig. 19), Cerci and paralobi (Fig. 20), Aedeagus and parameres (Fig. 21)

Female

Body length 7.0 – 11.1mm. Similar to the male except: eyes dichoptic, frons a little wider, fronto-orbital bristles present. Sternites 1-5 (Fig. 17).

Female genitalia

Dorsal view of ovipositor (Fig. 15), Ventral view of ovipositor (Fig. 16)

Material examined

Himachal Pradesh: Shimla 2208M (11♂♂, 3♀♀) 9.X.1999; Naldhera-2044M (14♂♂, 7♀♀) 9.X.1999; Kothi-2530M (3♂♂, 1♀) 10.IX.2000; Dalhousie-2036M ((2♂♂, 2♀♀) 18.IX.2000. Coll. Inderpal Singh Sidhu.

Distribution

India (Assam, Chandigarh, Jammu and Kashmir, Himachal Pradesh, West Bengal, Meghalaya), Myanmar, Nepal, Taiwan and China.

Hototype depository

BMNH, London, England.

Remarks

This species is closely similar to *C. loewi* Enderlein from which it can be differentiated as depicted in the key. This species is unique among the Indian species because of presence of completely black prothoracic spiracle. According to Senior-White *et al.* (1940), it is larviparous though not much is known about its life history.

iv) *Calliphora loewi* Enderlein, 1903 (Figs. 22-28)

- *Calliphora vomitoria* loewi Enderlein, 1903. *Wiss. Ergeb. Deutsch. Tiefsee-Exped., Valdivia*, 3: 254.
- *Onesia germanorum* Villeneuve, 1907. *Ann. Soc. Ent. Fr.*, 76:398.
- *Calliphora mortician* Shannon, 1923. *Inst. Insec. Mensr.*, 11(7-9): 116.
- *Calliphora loewi* Enderlein: Enderlein, 1934. *Sitzb. Ges. Naturf. Freude Bere*, 1934: 189.
- *Calliphora tianshanica* Rohdendorf: Sun et Zhang, 1982. *Ins. Xiz.*, 2:223 (misidint.).
- *Calliphora loewi* Enderlein, 1903: Fan *et al.*, 1997. *Fan et al.*, 1997. *Fauna Sin.*, 6: 298.

Male

Body length 9.0-10.2mm.

Head

Eyes bare, subholoptic, facets uniform; frons reddish brown to dark brown, narrow as it approaches vertex; parafrotaia black with silver tomentum, narrower than frons at base; frontal bristles well developed; fronto-orbital bristles absent; ocellus with ocellar and postvertical bristles; vertical bristles present, prevertical and outervertical bristles absent; parafacialia greyish brown with hair; face greyish, bare; facial

carina absent; epistome brown; medianae black, bare; jowls, genae and postgenae metallic black with black hair; vibrissae present just above oral margin; peristomal bristles weak; postorbit black with silver tomentum; occiput greyish with black and grey hair; 1st and 2nd antennal segments dark brown; 3rd segment black with grey dusting, length of 3rd segment about 3X that of 2nd; arista dark brown, long plumose; palpi orange and slender.

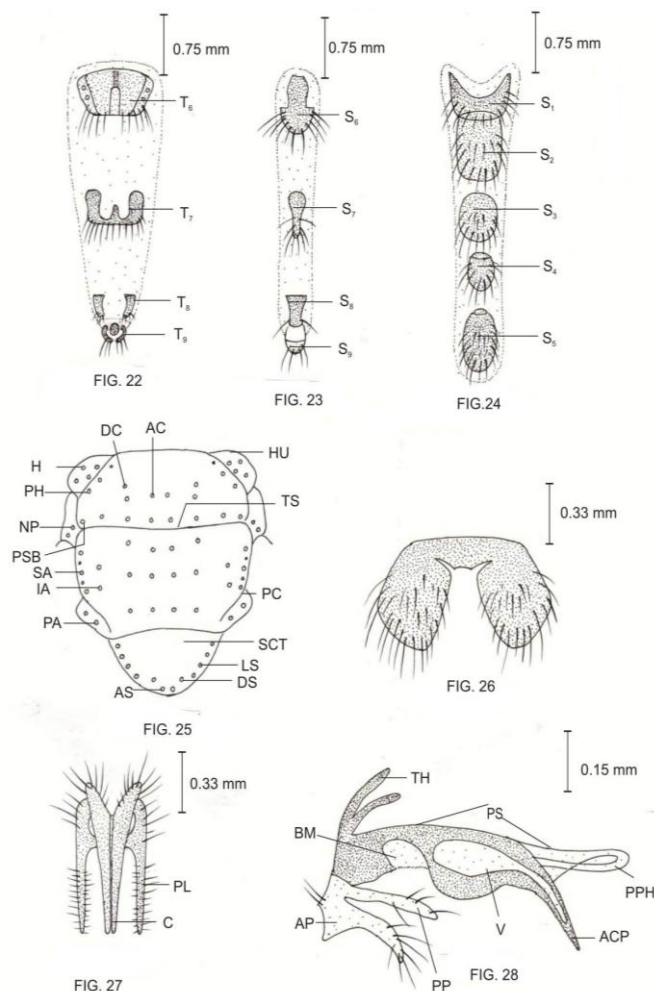


Fig 22-28: *Calliphora loewi*

Thorax

Black to indigo blue with whitish dusting; humerus and postalar callus concolorous with dorsum; prothoracic spiracle brown; propleuron hairy; prosternum with marginal hair; postalar declivity hairy; supraspiracular convexity with fine pubescence; suprasquamal ridge with anterior tuft.

Chaetotaxy (Fig. 25): Acrostichals 2+3; dorsocentrals 3+3; intra-alars 1+2; presutural present; humerals 4; posthumerals 3; notopleurals 2; supra-alars 5; post-alars 2; lateroscutellars 4; apicostutellar and discostutellar 1 each; sternopleurals 2+1; propleural and prostigmatic present.

Wings

Hyaline, infuscated toward anterior margin and base; stem vein (R) bare; R1 bare; R4+5 with several short setae on dorsal and ventral sides of basal node; first posterior cell (R5)

open; epaulet and basicosta black; subcostal sclerite brown, bare; alar and thoracic squamae dark brown, black hair present on outer margin of alar squama and dorsal surface of thoracic squama, outer margin of thoracic squama yellow with yellowish hair; halteres brown.

Legs

Black; fore- and hindfemora with bristles on both dorsal and ventral sides while midfemur with bristles on ventral side only; foretibia with 1 bristle at middle and 3 at apex; midtibia with 1 bristle at base, 1 at middle and 4 at apex; hindtibia with 1 bristle at base and 2 at apex.

Abdomen

Dark blue with greyish dusting; tergite 2 darker than others and with weak marginal bristles, tergites 3-5 with strong marginal bristles; sternites 1-5 with numerous long black hair; sternite 5 with deep incision posteriorly; hypopygium inconspicuous.

Male genitalia

Fifth sternite (Fig. 26), Ceri and paralobia (Fig. 27), Aedeagus and parameres (Fig. 28)

Female

Body length 11.0-11.5mm. Similar to the male except: eyes dichoptic, frons black, fronto- orbital bristles present, outervertical bristles well developed. Sternites 1-5 (Fig. 24).

Female genitalia

Dorsal view of ovipositor (Fig. 22), Ventral view of ovipositor (Fig. 23)

Material examined

Uttarakhand: Pandukeshwar-1857M (2♂♂, 1♀) 28.VI.1992. Coll. Dr. Devinder Singh.

Distribution

India (Uttarakhand), Japan, Mongolia and entire Europe.

Holotype depository

Not traceable.

Remarks

C. loewi has been reported from India for the first time by Sidhu and Singh (2002). According to Kano and Shinonaga (1968) this species is available generally in the high mountainous areas. It is a rare species and only 3 specimens could be collected during the present studies.

References

1. Anderson GS. The use of insects in death investigations: An analysis of cases in British Columbia over a five year period. *Can. Soc. Forens. Sci. J.*, 1995; 28:277-292.
2. Bharti M. An updated checklist of blowflies Diptera: Calliphoridae from India. *Halteres*, 2011; 3:34-37.
3. Catts EP, Haskel NH. *Entomology and Death: A procedural guide.* Clenson. SC Joyce's Print Shop, 1990.
4. Greenberg B. Forensic Entomology: Case studies. *Bull. Ent. Soc. Am.*, 1985; 31:25-28.

5. Kano R, Shinonaga S. *Fauna Japonica, Calliphoridae Insecta: Diptera*, 1968.
6. Lord WD, Adkins TR, Catts EP. The use of *Synthesiomyia nudesita* Vander Wulp Diptera: Muscidae and *Calliphora vicina* Robineau-Desvoidy Diptera: Calliphoridae to estimate the time of death of a body buried under a house. *J Agri. Entomol.*, 1992; 9:227-235.
7. Macleod J, Donnely J. Some ecological relationships natural populations of Calliphorinae blow flies. *J Anin. Ecol.*, 1957; 26:135-170.
8. Mihalyi F. Rearing flies from faeces and meat, infected under natural conditions. *Acta. Zool. Hung.*, 1965; 11:153-164.
9. Nolte KB, Pinder RD, Lord WD. Insect larvae used to detect cocaine poisoning in a decomposed body. *J. Foren. Sci.*, 1992; 37:1179-1185.
10. Senior-White R, Aubertin D, Smart J. *The Fauna of British India, including the remainder of the Oriental region, Diptera, Family Calliphoridae*, Taylor and Francis, London, 1940, 6.
11. Sidhu IS, Singh D. Blow flies Diptera: Calliphoridae collected from North-Western region including two new records from India. *UP Jour. Zool.*, 2002; 22:93-95.
12. Smith KGV. *A manual of Forensic Entomology.* Cornell Univ. Press, Ithaca, New York, 1986.