Universal Impact Factor0.9285:2012; 1.2210:2013

Index Copernicus
ICV 2011: 5.09
ICV 2012: 6.42
ICV 2013: 15.8
ICV 2014:89.16

NAAS Rating
2012 : 1.3;
2013-2014-2015:2.69

Received on:
16th May 2016

Revised on:
15th June 2016

Accepted on:
15th June 2016

Published on:
1st July2016

Volume No.
Online & Print
77 (2016)

Page No.
52 to 64

Life Sciences Leaflets is an international open access print & e journal, peer reviewed, worldwide abstract listed, published every month with ISSN, RNI Free- membership, downloads and access.

FIRST RECORD OF SARCOPHAGID DIPTERAN *PARASARCOPHAGA* (*THOMSONEA*) *ARGYROSTOMA* FROM MAHARASTRA STATE OF INDIA

LUBNA A. KHAN*; SURESHCHANDRA P. ZAMBARE1 AND FAHD M. ABDAL ALGHALIL*

***PH.D SCHOLARS, 1PROFESSOR, DEPARTMENT OF ZOOLOGY, DR. BABASAHEB AMBEDKAR MARATHWADA UNIVERSITY, AURANGABAD – 431004, MAHARASHTRA, INDIA.**

Corresponding author's e-mail: *lubna.k730@gmail.com*

ABSTRACT:

Generally, the blow flies and flesh flies are found on dead and decaying bodies which give many clues regarding the death of the victim for forensic scientists. Here, we have reported for the first time, the presence of *Parasarcophaga* (*Thomsonea*) *argyrostoma* (Robineau-Desvoidy, 1830) flesh flies, from the sample collected from Beed district of Maharashtra State, India. In present study the morphological characters, structure of genitalia and sternite of male, cephaloskeleton, posterior spiracles, spines on thoracic segment and pupa are used as identification keys along with its geographical habitat reported in India. *P.argyrostoma* is not only found as vector of different microorganisms but is also reported to cause Myiasis in live human and animals.

KEY WORD: *Sarcophagidae, Parasarcophaga argyrostoma, Beed district, Cephaloskeleton, Posterior spiracles, Myiasis.*

INTRODUCTION:

Entomology, the branch of science that deals with the study of insects, while Forensic science is used in medico-legal issues (Haskel and Catts, 1990). Insect colonies become visible after few minutes of death and can

persist longer until the body gets skeletonized. Most commonly found insects near dead bodies are Dipteran species (Calliphoridae and Sarcophagidae) as the first colonizer flies, followed by Coleopteran species (Heo *et al*., 2007). In the natural environment, insects start colonizing the corpse according to the specific sequence called as 'fauna succession'. Adults of Calliphoridae and Sarcophagidae are the major species attracted in the initial stage of decomposition. The observations of entomological fauna from animal cadavers are the important aspect of forensic investigations especially in the estimation of Post Mortem Interval (PMI) (Lee *et al.*, 2004). 'Myiasis', the infestation of human and animal body tissue with Dipterous fly maggots, commonly found in the tropical countries where, fly population is abundant (Seema *et al.*, 2012). Fly maggots are generally found in wounds, natural orifices and also found in episiotomy wounds. Fly maggots can cause gastric, intestinal and opthalmo-myiasis. The larvae can also found in decomposing matter and may be attracted to wounds of live species both in humans and animals for larviposition (Gardiner *et al.*, 1983; Tarek *et al.*, 2011; Kulkarni *et al.*, 2012 and Seema *et al.*, 2012). Hence, the study of life cycle of these flies is important in the field of medical and veterinary science. The family Sarcophagidae comprises of near about 2500 species worldwide with more than 100 genera and many Sarcophagid species are necrophagus in nature feeding on corpse (Fan and Pape, 1996). In India 117 presented species belongs to 38 genera of three subfamilies Sarcophaginae, Miltogrammatinae and Paramacronychiinae (Nandi, 2002; Sinha and Nandi, 2002 [a]; 2002 [b]). The larvae are laid by adult flies on animal tissue, therefore, these flies are also known as 'flesh- flies'. Flesh flies are found in close association of human activities, adult flies visit the feces, decaying substances and also feed on flowers (Azza *et al.*, 2003.).

Parasarcophaga argyrostoma (Robineau-Desvoidy, 1830) species belongs to the genus Parasarcophaga (Johnston & Tieges 1921); subgenus Thomsonea (Rohdendorf, 1937). *Parasarcophaga argyrostoma* species is not found in the form of large colonies, but can be collected from bushes and also found in association of some parasites and microorganisms such as *Escherichia coli*, *Mycobacterium laparae*, *Mycobacterium tuberculosis*, *Mycobacterium phlei* and *Neisseria cattarrhalis* (Greenberg, 1971 and Nandi, 2002). Larvae of *P. argyrostoma* normally develop in decaying meat but are also parasitoids of various animals (Povolný D and Verves, 1997). *P. argyrostoma* species is also capable of causing genito-urinal (vaginal) myiasis in human (Azza *et al.*, 2003). *Parasarcophaga argyrostoma*, abundantly found in the many parts of world and reported many cases of death and myiasis, so the detailed study about its morphology and developmental

stages need to be known which will be helpful in detection of its infestations and in determination of PMI (Martin and Christian, 2002).

MATERIAL AND METHODS:

During collection, the three days decayed meat was kept near the group of shrubs and within 20 minutes the flesh flies were observed on and around the meat sample. Mixed samples of Calliphoridae and Sarcophagidae were collected by using insect collecting net. After collection the flies were carried to lab, identified and separated using taxonomical keys and reared. Pieces of fresh meat were placed in petri dishes for larval deposition at room temperature 25±˚C in separate culture chambers. Approximately after 2-14 hrs, when the newly laid larvae were observed in meat sample, it was transferred to plastic containers and covered with muslin cloths. Larvae are reared until maturity, for pupation necessary medium is provided and reared up to next generation. The 3rd instar larvae were killed in KOH for their identification by dissecting and careful taxonomical identifications were done of their anterior and posterior spiracles, cephaloskeleton, papillae, excretory pore and of spinouse stripes on thorax (Julian, 1967 and Zeinab *et al.*, 2015). Adult males were used for identification by dissecting their genital organs and using taxonomical & morphological identification keys (Nandi, 2002 and Zeinab *et al.*, 2015), male genitalia were dissected under the dissecting microscope (Erma optical works Tokyo No. 44883) and photograph was taken under the trinocular microscope Magnus (MLX-DX No.4B525145) with the help of Sony Digital camera 16.1MP, 5X Optical Zoom.

The abdominal segments of three to four male flies were dissected and kept in 10% KOH for 24-36 Hrs. The genitalia were dissected and mounted using Ethanol followed by clearing in Xylene as per routine procedure (Arnoldos, 2013 and Chakroborty, 2014).

RESULTS:

Mostly the species of family sarcophagidae are carnivorous and larviparous in nature (Julian, 1967). Hatching of the eggs takes place just before deposition in uterus of female. Gestation in all of these larviparous species occurs from 10-16 days from the time of copulation, larviposition period is shorter. The fecundity ratio is 80- 300 larvae / female at one deposition (Clausen, 1940 and Julian, 1967). The *Parasarcophaga argyrostoma* is carnivorous; it can breed on flesh matter and poultry dropping (Bohart and Gressit, 1951 and Julian, 1967).

In India, *Parasarcophaga argyrostoma* species was reported in states of Gujarat (Girnar hills, Junagadh), Haryana (Ambala), Rajasthan (Jaipur), and Uttarakhand (Massoorie) (Nandi, 2002). Formerly, Massoorie was under Uttar Pradesh state, but now it came under Uttarakhand State.

Uttarakhand State came into existence on 9 November 2000(U.P. Reorganization Act. 2000). This is the first report of *Parasarcophaga argyrostoma* occurrence in Maharashtra State. During the study, the species was observed in the contiguous area of SRTM Medical College, Taluka Ambajogai, Dist. Beed, State of Maharashtra, India (fig.2.), between 18° 44' 7.6416" N 76° 22' 12.7740" E (www.latlong.net). Where maximum temperature ranges up to 40^0C- 42^0C & minimum temperature is up to 12^0C - 16^0C. Site of collection is at 530 m above sea level having a large ground with randomly distributed shrubs.

Morphology of male:

Male fly has body length up to 8-15 mm. Head is made up of different structures as frons, parafrontal region, parafacial region, post vertical region, face, compound eyes, vertex, facial ridges, antennae, peristome etc. along with the presence of number of ridges and hair like bristles. Frons are about half that of one eye in width, frontal vita is black in color. Parafrontal is black with silvery pollen and short scattered hairs. Parafacial is black with silvery pollens and a row of short hairs near the eye margin. Antennae are black and dark brown with silvery pollen. Longer arista is plumose (feathered) up to its basal two-third of length. Facial ridge are brown with silvery pollen and number of short hairs. Vibrissae are long, crossed and arranged slightly away from each other. Ten to twelve fronto-orbital bristles are present, of which posterior three bristles are reclined, anterior three lying below base of antennae and attending the length of about half of second antennal segment. Remaining four to six fronto-orbital bristles are heading forwards. Gena is black with black hairs, post gena is black having gray hairs. Ocellar triangle is black colored along with short black hairs. Inner vertical bristles are well developed, outer vertical bristles are short and post vertical bristles are partial in length of inner vertical bristles. At the side of post ocular cilia paired rows of post ocular setae are present. Palpi are slender in structure and black in color. Proboscis black colored. Thorax constitutes 3 black longitudinal stripes along with grayish black shade. *Acrostichal bristles* 0+1; *intra alar bristles 0+3; Presutural bristles* 1; *humeral bristles* 4; *post humeral bristles* 2; *notopleural bristles 3*; *post alar bristles* 2; *supra alar bristes* 3; *scutellum* 1+1+1; *meso pleural bristles* 6-7; *hypo pleural bristles* 10. Upper part of propleuron is uncovered and black with silvery pollen. Prostigmatic and propleural bristles are well developed having short hairs. One pair of apicoscutellar and discoscutellar bristles and two pairs of lateroscutellar bristles are present. Fore femur, mid femur, hind femur and fore tibia, mid tibia, hind tibia is well developed and having characteristic distribution of bristles. Abdomen is black having grey checkered pattern. There are no median marginal bristles on second and third abdominal tergites, but second tergite with two and third tergite with one lateral marginal bristles,

fourth tergite with a pair of median and one lateral marginal bristles, fifth tergite having a row of fourteen-sixteen marginal bristles. Sternites six in number, second sternite with long hairs, third sternite and fourth with short hairs, fifth is Y-shaped with wide transparent transom along with strong marginal spines laterally and short hairs terminally present on arms (fig.1.b.). First and second genital segments are black with short hairs and without marginal bristles. Inner forceps are wider and straight on basal end; outer forceps is oval with long hairs (fig.1.a.). Anterior paramere and posterior paramere are curved but the prior is less curved than the posterior one along with three short hairs present apically. Theca and paraphallus both are sclerotised but theca is shorter than paraphallus. Lateral plate of paraphallus is curved with two projections as styli of glans and ventralia. Styli of glans are wide with a pair of strongly chitinous lateral structures; ventralia are bilobed and well developed. On apical plate of paraphallus a pair of long projecting lateral processes along with a separate median portion on membranous paraphallus is present.

Morphology of female:

Female has body length between 11-15 mm. Head of female is similar to that of male except the frons which are two-thirds of one eye. Not only two proclinate fronto-orbital bristles are present but also outer vertical bristles are well developed and ocellar bristles are clearly differentiated. On the thorax of female a single distinguishing feature, as comparative to male is the absence of apicoscutellar bristles and rest of the structure is same as in male. Abdomen generally having red colored genital segments. Sixth sternite is also red with two pairs of marginal bristles and a median protuberance, seventh sternite is without pits. Eighth sternites membranous have a pair of long delicate hairs on hind margin and anal sternite is transparent with short hairs.

Morphology of larvae:

According to Nandi (2002), the life cycle of fly *Parasarcophaga aryrostoma* comprises different developmental stages. Newly laid larvae are 2-3 mm in length and get matured in seven days. Mostly the development of larvae depends on clearing of alimentary canal and crop region because when larvae are in active feeding stage (i.e. 1^{st}, 2^{nd}, 3^{rd} instar), the alimentary canal and crop get darken and when the larvae get converted into pre pupa (late 3^{rd} instar) they stop feeding and try to leave the media and search for the suitable site for pupation, for this purpose dry saw dust was used as site for pupation (Povolný D and Verves, 1997).

Larvae of *Parasarcophaga argyrostoma* generally are yellow to white in color and their body is tapering from posterior to anterior end (James, 1947 and Julian, 1967). The larval 1^{st} instars are about 2-4 mm in length, does not have anterior spiracles on prothoracic segment but on posterior side two

caudal or posterior spiracles with 2 spiracular slits are present. These spiracular slits are surrounded by slightly sclretorized area, 2 mouth hooks are there. The 2nd instar is about is about 4-8 mm in length. Two pairs of mouth hooks are present. In second instar the posterior spiracles are clearly visible while, anterior spiracles are not clearly visible as compare to posterior spiracles because they are present in non sclerotized head. In 2nd instar the posterior spiracles has only two spiracular slits surrounded by distinctly scletorized peritreme. The 2nd instar develops within 20-60 Hrs after egg deposition. The 3rd instar is having 8-22 mm of length (fig.1.c.). It takes 60-192 Hrs for development. As like of 1st instar a single pair of mouth hook get reappeared and anterior spiracles are present. Inside posterior spiracles three slightly parallel slits get developed but the slit which is nearest to meson of spiracle is shorter and distant than remaining two slits. In 3rd instar the peritreme is discontinuous; densely sclerotized and its inner and outer margins between the slits are dorsally invaginated. The fully matured larvae generally measured 20-25 mm in length. Bands of spines are clearly observed on anterior margins of all body segments except prothorax. The non-scletorized head is retractable in thoracic region. The sensory papillae are present on cephalolateral rounde areas. Backwardly directed not prominent lines are observed on mouth openings ventrally. These lines may represent the pseudo-trachea in oral disc of adults. The mandibles or mouth hooks are black in color, paired, parallel, backwardly directed (retractable), de-curved and highly scletorized (fig.1.d.). The cephalo-pharyngeal skeleton is composed of three main parts as follows-

1. Mandibular sclerites or mouth hooks which are the anterior one and are jointed with hypostomal sclerite.
2. Hypostomal sclerite receives the opening of salivary duct. The base of both mandibular sclerites is joined by a small dentate sclerite.
3. Pharyngeal sclerite which is the most posterior and larger sclerite. It is formed of two vertical lamellae which are ventrally united to form a furrow in which the pharynx are located.

In fully developed larva, the body is composed of 3 parts as thoracic segment, abdominal segment and anal division. The thorax is without any appendages and 3 segmented. The bands of micro spines which are used mainly for locomotion are present on and around the anterior edges. On the either side of pro-thoracic segment anterior spiracles are present between pro-thoracic and meso-thoracic segment. Each anterior spiracle of *Parasarcophaga argyrostoma* bears 15 digits (Julian, 1967). The second segment is the abdominal segment, cylindrical in shape having 8 segments with bands of microspines. Out of these 8 segments 4th, 5th and 6th are the largest segment. On the ventral surface the bands of micro-spines are wider to enhance movement. On the dorsal side of each segment one or

two very minute folds of skin are present. The third and last body segment in 3rd larval instar is anal segment in which the posterior spiracles are present. These are known to be present in deep cavity of 8th abdominal segment. The outer margins of this cavity is having 12 tubercles, out of which 3 tubercles are on either side of dorsal half, 2 tubercles are on either side of ventral half. In the ventral side of deep spiracular cavity, between cavity and anal opening the prolegs are projected out called as Protuberances showing specific pattern of presence of microspines (fig.1.e.).

Morphology of pupa:

The fully matured 3rd instar get converted into pre-pupa which after few hours get enclosed in a rigid case and an inactive stage of development i.e. pupa. Pupa is a hard structure in which cast off-skin of 3rd instar get packed. Pupa is 10-13 mm in length, ovoid in shape and dark brown to maroon in color (fig.1.g.). The microspines are also visible on pupa but are compressed together due to the contraction of larvae. The definite abjuration of head exists on anterior end of pupa, while posterior spiracles remain visible in the deep spiracular cavity. A suture like structure in anal region runs diagonally from posterior to anterior direction dorsoventrally. For pupation, generally, it takes 190-193 Hrs from time of larval deposition and it takes near about 290-300 Hrs to complete.

DISCUSSION:

Sarcophaga (Liosarcophaga) tibialis Macquart, 1850, *Sarcophaga (Liosarcophaga) jacobsoni* Rohdendorf, 1937, *Sarcophaga (Liopygia) crassipalpis* Macquart, 1839 and *Sarcophaga (Liopygia) argyrostoma* (Robineau-Desvoidy, 1830) are closely associated species to each other worldwide generally. Only three taxa (*S. crassipalpis*, *S. argyrostoma* and *S. dux*) are constantly found as necrophagous and occasionally breeding in carrion and therefore is of little importance in forensic investigations (Daniel *et al.*, 2012).

The characteristic feature of *P. argyrostoma* is that, when the 1st instar are emerged they shows metapnuestic type of respiratory system, while in 2nd and 3rd instars it get developed into amphinuestic system of respiration (Julian, 1967). Generally in *P. argyrostoma* pupation starts on 8th day and last for 12 days as adults are emerging out within 20 days from the period of larval laying.

There is high level of inter-specific similarities between the morphology of larvae of Sarcophagidae, so the different important identification keys used in larval taxonomy are as follows:

1. Shape of cephaloskeleton (fig.1.d.).
2. Structure of anterior spiracles.
3. Shape and distribution of spines in spinose band (fig.1.e.).
4. Structure and position of posterior spiracles (fig.1.f.).

5. Size and position of papillae around the entrance of spiracular cavity.

(Greene, 1925; Zimin, 1948; Kano *et al.*, 1951; Sanjean, 1957; Ishijima, 1967; Nandi, 1980; Sukontason *et al.*, 2010; Velasquez *et al.*, 2010; Krzysztof *et al.*, 2015; Singh *et al.*, 2012 and Ubero-Pascal *et al.*, 2015).

Some important identification features observed about posterior spiracles of *P. argyrostoma* are (fig.1.f.):

1. Internal walls of posterior spiracles are swelled.
2. Spiracles are having two small appendices equal in size.
3. The peritreme wall is thick having small space (ventro- mesal area) opened.
4. 3 long narrow openings 'slits' are present, which are having equal distance with bowed heads above, of wall of pertreme.
5. Peritreme is not closed completely.

Chrysomya megacephala (Fabricius, 1874) was also observed in the area in association with *P. argyrostoma*. The area of collection was surrounded by different domestic activities. The larvae of flesh fly *P. argyrostoma* have also been reported to cause Myiasis in human (Sacca, 1945; James, 1947; Burges, 1996; Nandi, 2002) and are known to cause secondary myiasis in sheep (Baranov and Jezic, 1928; Nandi, 2002).

The eggs of flesh flies are also found on corpse and can be used in forensic investigations as entomological evidence with relation to the temperature similar to death scene (Sukontason, 2004). These species of *P. argyrostoma* are already native of western zone of India as Gujarat, Haryana, Rajasthan, and Uttarkhand (Nandi, 2002). The geographical spread of the blowflies is usually aided by the movement of man, transport by vehicles, with ships and aircraft (Baumgartner, 1993; Williams and Villet, 2006 and Bruhn, 2011).

The present study reports the record of distribution of *P. argyrostoma* in India. During collection it was observed that the *P. argyrostoma* species has extended its geographical area near about 1,119 km (Fig.2), from western zone to south western zone. The presence of *P. argyrostoma* in the region may be because the people living in the surrounding area of collection site visit the different cities of Gujarat for different economic and personal purposes. Also there are about 250 to 300 families from Gujarat having marriage relations with other families originally from Beed district and most of them live near by the collection site. Another possibility may be because of the incoming of large number of cattle herds for grazing in certain seasons. The poor sanitary conditions, more amount of domestic litter, and lack of sewage sanitation system creates favorable environment to increase the population

of the flies in the area. As larvae can get sufficient amount of food there and are able to serve as host for different bacteria and pathogens by which different diseases can be spread to human beings (Greenberg, 1971). The blow fly, *C. megacephala* which was observed in association of *P. argyrostoma* at collection site, is also reported as vector of pathogens, including bacteria, protozoan and helminthes, and as a causal agent of myiasis in Southern Atlantic Island and different parts of the world (Greenberg, 1973; Carmo and Vasconcelos, 2014). Continuous to and fro of humans from western regions of India, from Gujarat, Rajasthan, Uttarakhand and Haryana, has increased the positive count of medically and forensically important flesh fly *P. argyrostoma* in this region (Nandi, 2002).

ACKNOWLEDGMENTS:

We sincerely thank University Grant Commission (U.G.C) for financial support and Department of Zoology, Dr. Babasaheb Ambedkar Marathwada University, Aurangabad, Maharashtra, India for providing the lab facility.

CONFLICT OF INTEREST:

The Author(s) declare(s) that there is no conflict of interest..

REFERENCES:

Arnaldos S.; Torres Tomas M.I.B. and Garcia Garcia M.D. 2013. First data on the development of the life cycle of the *Sarcophaga cultellata pandelle*, 1896 (Diptera: *sarcophagidae*). *Caud. Med. Foren.*, 19, 6-12.

Awad A.; Abdel- Salam S.; Abdou El-Ela R.; Abdel- Aal A. and Mohammed D. 2003. Ultrastructure comparison of the sensory morphology of the first instar and third instar larvae of *Parasarcophaga argyrostoma* (Robineau-Desvoidy) (Diptera: Sarcophagidae). *Egyptian Journal of Biology*, 5, 148-154.

Baranov N. and Jezic J. 1928. Fligenmaden als Wundschmarotzer beidan Haustieren in Südserbien. Z. *Parasitkde*, 1, 416-422.

Baumgartner D.L. 1993. Review of *chrysomya rufifacies* (Diptera: Calliphoridae). *J. Med. Entom.*, 30, 338-352.

Bohart G.E. and Gressitt J.L. 1951. Filth inhabiting flies of Guam. Bernice P. Bishop MUS. Butt. 204, 152, 17.

Bose S.; Saini S.; Barapatre R. and Mathew S. 2012. Opthalmomyiasis Externa: A case report. *Journal of Clinical and Diagnostic Research*, 6, 1079-1080.

Bruhn T. 2011. Sequence and analysis of the mitochondrial DNA control of nine Australian species of the genus *Chrysomya* (Diptera : Calliphoridae), Master of science thesis university of Wollongong. School of Biological Sciences, Australia.

Burges N.R. 1996. A case of myiasis in London. Trans. *R. Soc. Trop. Med. Hyg.*, 60, 432-433.

Carmo F.R. and Vasconcelos S.D. 2014. First record of the blow fly *Chrysomya megacephala* (Diptera: Calliphoridae) on a Southern Atlantic island: implications for disease transmission in a protected environment. *Vector ecology*, 50, 670-420.

Chakroborty A.; Ansar W.; Ghosh S.and Banerjee D. 2014.The first report of the life cycle of *Sarcophaga (*L*) dux* on dead reptilian carcass: Their application as forensic indicators. *Scholar Academic Journal of Biosciences*, 2, 731-739.

Cherix D.; Wyss C. and Pape T. 2012.Occurance of flesh flies (Diptera: *Sarcophagidae*) on human cadavers in Switzerland and their importance as forensic indicators. *Forensic Science International*, 220, 158-163.

Chin H.C; Marwi M.A.; Firdaus A.; Salleh M.; Jeffery J. and Omar B. 2007. A preliminary study of insect succession on pig carcass in a palm oil plantation in Malaysia. *Tropical Biomedicine*, 24, 23-27.

Clause C.P. 1940. *Entomophagus Insects*. New York and London, Mc Graw Hill Book Co.INC.

Fan Z.D. and Pape T. 1996. Checklist of *Sarcophagae* (Diptera) recorded from China. *Studia Dipterologica*, 3, 273-258.

Gardiner C.H.; James V.S. and Valentine B.A. 1983. Visceral myiasis caused by *Musca domestica* in a cat. *J. M. Med. Assoc.*, 182, 68-69.

Greenberg G. 1971. Flies and Diseases. Vol. 1, Princeton University Press, Princeton, New Jersey, p.1-856.

Greenberg, B. 1973. Flies and Disease. Vol. 2. Biology and Disease Transmission. Princeton Univ. press, 1-447.

Greene C.T. 1925. The puparia and larvae of sarcophagid flies. Proc US, Natl Mus, 66, 1–26, 1–9.

Haskel N.H. and Catts E.P. 1990. Entomology and Death: A procedural Guide. Joyce's Print Shop, Clemon , SC, 52-97.

Imms A. D. 1934. A general text book of entomology. New York, E. P. Dutton and Co. Inc.

Ishijima H. 1967. Revision of the third stage larvae of synanthropic flies of Japan (Diptera: Anthomyiidae, Muscidae, Calliphoridae and Sarcophagidae). *Jpn. J. Sanit. Zool.*, 18, 47–100.

James M.T. 1947. The flies that cause myiasis in man. U.S. Dept. Agric. Misc. Pub. 631, 1-175.

Julian R. Yates. 1967. Immature stages of the flesh fly Parasarcophaga (Thomsonea) argyrostoma (Robineau- Desvoidy). University of Hawaii, Honolulu, Hawaii. *Proceedings, Hawaiian Entomological Society,* Vol.XIX, No.3.

Kano R.; Sato K. and Tange H. 1951. Notes on the flies of medical importance in Japan. Part 2. The larvae of Sarcophaga known in Japan. *Jpn. J. Exp. Med.* 20, 115–131.

Krzysztof Szpila; Rene Richet; Thomas Pape. 2015. Third instar larvae of flesh flies (Diptera: Sarcophagidae) of forensic importance-critical review of characters and key of European species. *Parasitol. Res.,* 114, 2279- 2289.

Kulkarni S.; Joshi S.; Bhalerao A.; Chopde Y. and Somalwar S. 2012. Myiasis: A boon or bane. *Journal of South Asian Federation of Obstetrics and Gynecology*, 4, 1-116.

Lee H.L.; Krishnasamy M.; Abdullah A.G. and Jeffery J. 2004. Review of forensically important entomological specimens in the period of 1972-2002. *Tropical Biomedicine Supplement,* 21 (2) 69-75.

Nandi B.C. 1980. Studies on the larvae of flesh flies from India (Diptera:Sarcophagidae). *Orient Insects,* 14(3), 303–323.

Nandi B.C. 2002. Fauna of India and the adjacent countries – Diptera vol. X *Sarcophagidae*, Director ZSI, Kolkata, 1- 608.

Povolny D.; Verves Y. 1997. The flesh flies of central Europe (Insecta, Diptera, Sarcophagidae). *Spix Supp*, 24, 1- 260.

Sacca G. 1945. Miiasi da *Sarcophaga falculata* Pand. *Rec. Ist. Sup.Sanita*, 8, 301-302.

Singh D.; Garg R. and Wadhavan B. 2012. Ultramorphological characteristics of immature stages of a forensically important fly Parasarcophaga ruficornis (Fabricius) (Diptera: Sarcophagidae). *Parasitol. Res.,* 110, 821–831.

Sinha S.K.; Nandi B.C. 2002a. *Parasarcophaga (Liosarcophaga) choudhuryi* sp. nov. (Diptera: Sarcophagidae) from Sagar Island, Sundarbans Biosphere Reserve, India, *Rec. Zool. Surv. India*, 100 (3 and 4), 117-211.

Sinha S.K.; Nandi B.C. 2002b. A new species of *Lioproctia* Enderlein (Diptera: Sarcophagidae) from Sundarbans Biosphere Reserve, India. *Proc. Zool. Soc. Calcutta,* 55(2), 39-41.

Sukontason K.; Bunchu N.; Chaiwong T.; Moophayak K. and Sukontason K.L. 2010. Forensically important flesh fly species in Thailand: morphology and developmental rate. *Parasitol. Res.*, 106:1055–1064.

Sukontason K.; Sukontason K.L.; Piangjai S.; Boonchu N.; Kurahashi H.; Hope M. and Olson J.K. 2004. Identification of forensically important fly using a potassium permanganate staining technique. *Micron*, 35, 391-395.

Tarek; A.El- Tayeb; Mayada. M. Gharib and Afal M. Al Gendy. 2011. Preliminary study to investigate the optimum parameters of Hematoporphyrin IX to control flesh fly (*Parasarcophaga argyrostoma). Journal of Entomology*, 8, 384-390.

The Uttar Pradesh Reorganization Act, 2000. 1-46 (available at www.ukpsc.gov.in).

Ubero-Pascal N.; Paños A.; GarcíaM-D.; Presa J.J.; Torres B. and Arnaldos M.I. 2015. Micromorphology of immature stages of Sarcophaga (Liopygia) cultellata Pandellé, 1896 (Diptera: Sarcophagidae), a forensically important fly. *Microsc. Res. Tech.*, 78, 148–172.

Velásquez Y.; Magaña C.; Martínez-Sánchez A. and Rojo S. 2010. Diptera of forensic importance in the Iberian Peninsula: larval identification key. *Med. Vet. Entomol.*, 24(3), 293–308.

Williams K.A. and Villet M.H. 2006. A new and earlier record of *Chrysomya megacephala* in South Africa, with notes on another exotic species, *Calliphora vicinia* (Diptera: Calliphoridae). *Afr. Invertebr.*, 47, 347-350.

Zeinab Afravi; Alireza Sanei-Dehkordi; Masomeh Pirmohammadi; Kamran Akberzadeh. 2015. Useful morphological characters of 3rd larval stages of three species of Sarcophagidae family (Diptera, Insecta). *Journal of Entomology and Zoology Studies*, 3(5), 483-486.

Zimin L.S. 1948. Key to the third instar larvae of synanthropic flies of Tadzhikistan. *Opred. Faun. SSSR*, 28, 1–114.

Fig.1. *Parasarcophaga (Thomsonea) argyrostoma* (Robineau -Desvoidy). a. Inner and outer forceps (posterior view); b. Fifth sternite of male; c. 3rd larval instar; d. Cephaloskeleton; e. Spines on thoracic segment; f. Posterior spiracles; g. Pupa

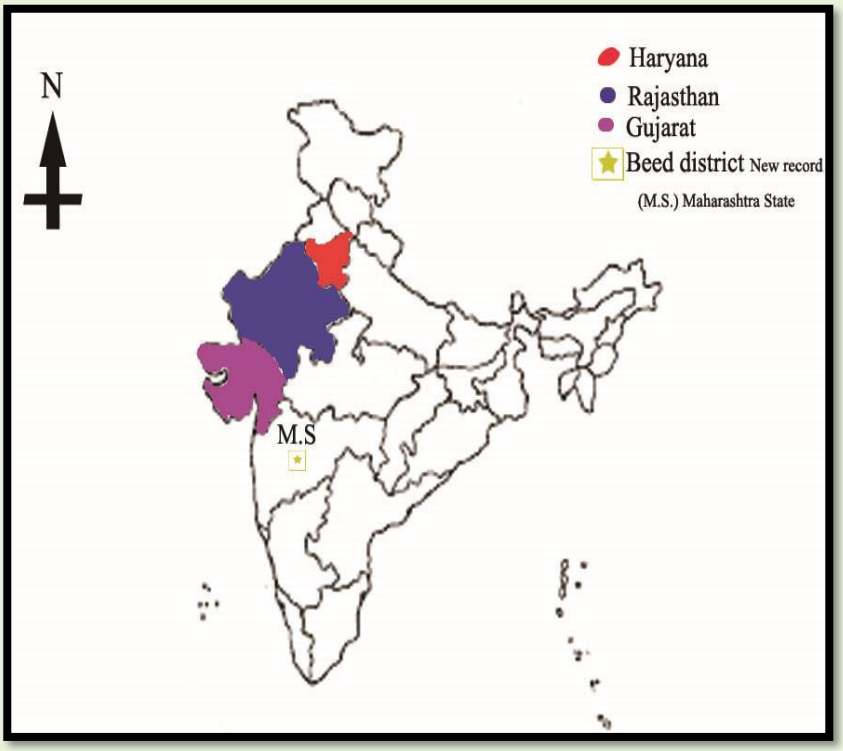

Fig.2. Map showing distribution of *Parasarcophaga argyrostoma* in India