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Geographical distribution of some forensically important species of beetles (Coleoptera: silphidae) from North India (INDIA)

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Abstract
This preliminary study highlights the importance of beetles belonging to the family Silphidae as forensic evidence. Although recorded specimens were reported earlier in prior studies but these species were not defined as forensically important. Silphidae (carrion beetles) are one of the several families of forensic importance in the order Coleoptera. It consists of two subfamilies i.e. Silphinae and Nicrophorinae and both are the frequent visitors of carrion. The work reported here monitored the presence of the carrion beetles (Coleoptera: Silphidae) by using bait traps with the meat of goat (*Capra* sp., Bovidae) in the summer of 2014 and 2015 from Himachal Pradesh and Punjab. Seven species of Silphidae were recorded: *Necrophila* (*Calosilpha*) *ioptera* (Kollar & Redtenbacher, 1848), *Necrophila* (*Deutosilpha*) *rufithorax* (Wiedemann, 1832), *Necrophila* (*Calosilpha*) *cyaniventris* (Motschulsky, 1870), *Necrodes littoralis* (Linnaeus, 1758), *Necrodes nigricornis* (Harold, 1875), *Nicrophorus nepalensis* (Hope, 1931) and *Thanatophilus minutus* (Kraatz, 1876).

Keywords: forensic entomology, silphidae, beetles, silphinae, nicrophorinae, carrion

Introduction
Forensic entomology is the application of insect biology in criminal investigations (Varatharajan and Sen, 2000). Conventional pathological examination of the corpse cannot provide time since death with accuracy if time after death is more than three days; consequently, an entomological investigation is essential in many cases. Insects feeding on carrion form a distinct faunal succession associated with the various stages of decomposition (Sert *et al*. 2012) [30]. Coleopterans tend to be associated with the later stages of decomposition, which is very important in terms of the dry bones of the body (Zhuang *et al*. 2011) [34]. But most researches have focused on flies, and beetles (Coleoptera) have been under-emphasized (Cai, *et al*. 2011) [5]. The majority of forensically useful beetles lack morphological features specific to particular instars and in order to estimate postmortem interval from immature insects, it is necessary to accurately determine which instars are present on the corpse (Fratczak & Matuszewski 2014) [8]. Silphidae is one of the forensically important families of beetles. They perform vital ecosystem functions by promoting the breakdown and recycling of organic matter into terrestrial ecosystems (Dekeirsschieter *et al*. 2010) [7]. Carrion beetles (Silphidae, Coleoptera) constitute a relatively small family of beetles counting less than 200 species worldwide (Sikes 2008) [32]. Most silphids are carrion feeders as their common name suggests but can also prey on other carrion inhabitants such as fly eggs or maggots and other small carrion beetles (Dekeirsschieter *et al*. 2011) [6]. Sometimes toxicological samples such as urine, blood, internal organs are not available in those cases adult, larvae or beetle remains such as exuviae, puparial cases or fecal material of beetles may be used for toxicological analysis (Dekeirsschieter *et al*. 2011) [6].
Silphids are large beetles; l0-35 mm long, frequently found associated with decaying organic matter. They are most commonly encountered at vertebrate carcasses and hence have the common name of carrion beetles. The habit of adults of some family members of interring small vertebrate carcasses has also led to the use of the common names of sexton beetles and burying beetles. Within the Silphidae, there are two subfamilies i.e. Silphinae and Nicrophorinae. Studies on a few species have shown that olfaction is of primary importance in finding food with the sensilla coelosphaerica of the terminal antennal segments being the principal olfactory structures involved. These sensilla are sensitive to hydrogen sulfide and some cyclic carbon compounds which are released as a carcass decays (Anderson & Peck 1985) [2].

Materials & Methods
The present study was conducted in two states of North India i.e. Punjab and Himachal Pradesh but silphids were only collected from the later. All the collection was done either using bait traps (Fig.1) or from dead animal houses (Fig. 2). Specimens were picked by forceps and preserved in 95% alcohol in the field for further identification. Identification was done with the help of Rescholar Stereo zoom microscope (Model No. RI-90-01) using relevant keys (Ruzicka & Schneider 1996, 2002, 2011; Ruzicka *et al*. 2000, 2011, 2015) [24, 25, 26] and then later got confirmed by the experts in the field as mentioned in the acknowledgement. Photography of the specimens was done with the help of Canon EOS 1200D.

Fig 1-4: Meat trap; *Necrophila* (*Deutosilpha*) *rufithorax* feeding on the carcass in the dead animal house; Collection site (Apple orchids) in Gharakar, Kullu, Himachal Pradesh; *Necrophila* (*Calosilpha*) *ioptera* showing necrophilous behavior on the decomposed carrion

Results

Seven species of Silphidae were identified during 2014-2015, one Nicrophorinae: *Nicrophorus nepalensis* and six Silphinae: *Necrophila* (*Calosilpha*) *ioptera*, *Necrophila* (*Deutosilpha*) *rufithorax*, *Necrophila* (*Calosilpha*) *cyaniventris*, *Necrodes littoralis*, *Necrodes nigricornis* and *Thanatophilus minutus.* Immature stages were also collected but not examined.

***Nicrophorus nepalensis* Hope, 1831 (Fig. 5)**

Entirely black species except for the clubs of the antenna is orange -brown and an orange-brown pattern is present on the elytra.

Material examined- Collected near apple orchids in Gharakar in Kullu, Himachal Pradesh, on bait traps. 1♀ and 1♂.

Distribution- In India known from Jammu and Kashmir (Schawaller 1982; Ruzicka & Schneider 2002; Sikes *et al*. 2006) [24, 28, 32], Himachal Pradesh (Nishikawa & Sikes 2008) [18, 32], Uttarakhand (Schawaller 1982; Sikes *et al*. 2006) [28], Madhya Pradesh (Sikes *et al*. 2006) [32], West Bengal (Schawaller 1982; Sikes *et al*. 2006; Nishikawa & Sikes 2008) [18, 28, 32], Sikkim (Sikes *et al*. 2006) [32], Meghalaya (Ruzicka *et al*. 2000; Sikes *et al*. 2006) [25, 32] and Arunachal Pradesh (Ruzicka *et al*. 2011) [23].

Also reported from Pakistan, Laos, Myanmar, China, Thailand, Malaysia, Cambodia, Japan, Philippines (Ruzicka *et al*. 2011) [26].

***Necrophila* (*Calosilpha*) *ioptera* (Kollar & Redtenbacher, 1848) (Fig. 6)**

The pronotum is orange in dorsal view and has a black spot in the center of the disk.

Material examined- 27 specimens were collected from Gharakar in Kullu, Himachal Pradesh on meat bait trap.

Distribution- Known from India: Himachal Pradesh, Uttar Pradesh, Meghalaya and Assam (Schawaller 1982) [28]. First reliable records from Uttarakhand, Uttar Pradesh, Bihar, Sikkim, West Bengal and Assam by Ruzicka *et al*. (2015).

Also reported from Nepal (Schwaller 2003) and Pakistan (Ruzicka *et al*. 2015).

***Necrophila* (*Deutosilpha*) *rufithorax* (Wiedemann, 1832) (Fig. 7)**

Pronotum has 4 spots on it. The apex of elytron is truncate in the case of males while in females it elongates with convex apex.

Material examined- Collected on the bank of Chakki River in District Pathankot, Punjab 1♀ and 1♂ and Gagret, Himachal Pradesh near Gagret- Hoshiarpur road (NH 70) 11♀ and 13♂ on decaying cow carcass.

Distribution- It is known from Bihar, Chhattisgarh, Karnataka, Madhya Pradesh, Maharashtra, Meghalaya, Pondicherry, Uttrakhand, Uttar Pradesh, West Bengal and Rajasthan in India (Ruzicka & Schneider 2011) [23]. The first report from Punjab and Himachal Pradesh.

Other than India it is also reported from Nepal & Sri Lanka

(Ruzicka & Schneider 2011) [23], Thailand (Ruzicka *et al*. 2000) [22] and Laos (Ruzicka & Schneider 2003) [24].

***Necrophila* (*Calosilpha*) *cyaniventris* (Motschulsky, 1870) (Fig. 8)**
Flattened body. Pronotum is orange in dorsal view with poorly delimited medial spot on the disk.

Material examined- Collected near apple orchids in Gharakar, Kullu, Himachal Pradesh by placing bait traps using mutton (*Capra* sp., Bovidae) during June 2015. Total 13 specimens were collected.

Distribution- In India known from Punjab (Bharti & Singh 2003), Himachal Pradesh, Uttarakhand, West Bengal, Sikkim, Meghalaya, Arunachal Pradesh, Nagaland and Manipur (Ruzicka *et al*. 2015) [20].
Also reported from Nepal, Myanmar and Vietnam (Schwaller 1982) and Thailand (Ruzicka *et al*. 2000) [21].

***Necrodes littoralis* (Linnaeus, 1758) (Fig. 9)**
Black in colour. Antennae are straight and last 3 antennal segments are reddish-brown in colour. In males, posterior femura is highly incrassated while in opposite sex posterior femura is simple and slender.

Material examined- 7 specimens were collected from Gharakar, Kullu, Himachal Pradesh on bait trap while 2 specimens were collected from the cow carcass near swan river. Out of all the collected specimen 1♀ and 8♂.
Distribution- Uttar Pradesh (Ruzicka & Schneider 2002) [22] and first record from Himachal Pradesh.
Also reported from China (Ruzicka & Schneider 1996) [23] and Iran, Pakistan, Afghanistan (Ruzicka & Schneider 2002) [24]

***Necrodes nigricornis* (Harold, 1875) (Fig.10)**
Black in colour. Antennae are all black.

Material examined- 3 specimens were collected from Gagret, Una, Himachal Pradesh near swan river on calf carcass.
Distribution- Known from Uttar Pradesh, Assam (Ruzicka & Schneider 2002) [25] and first record from Himachal Pradesh.
Reported from Bangladesh, Korea, Vietnam (Ruzicka & Schneider 2002) [26] and China, Taiwan, Japan (Portevein 1926).

***Thanatophilus minutus* (Kraatz, 1876) (Fig.11)**
It has a shiny black body. Pygidium and Propygidium are reddish brown in colour.

Material examined- 12 specimens were collected Gharakar, Kullu, Himachal Pradesh by using bait traps with mutton.
Distribution- Known from Himachal Pradesh, Uttarakhand, Madhya Pradesh, Sikkim and Assam (Ruzicka *et al*. 2011) [23].
Reported from Tibet (Schwaller 1982) and Afghanistan (Ruzicka & Schneider 2002) [25].

Table 1: Collected specimens of forensically important beetles along with their geographical co-ordinates.

Family	Genus	Species	Date of collection	Location	Co-ordinates
Silphinae	Necrophila	*Necrophila ioptera*	26-v-2014	Kullu, H.P.	$31^0$57’35.9”N $77^0$07’21.8”E
		Necrophila rufithorax	20-vi-2014	Gagret, H.P.	$31^0$66’23.11”N $76^0$06’93.86”E
					$31^0$65’69.42”N $76^0$05’81.80”E
			30-vi-2015	Pathankot, Punjab	$32^0$16’11.14’’N $75^0$42’58.54’’E
		Necrophila cyaniventris	22-vi-2015	Kullu, H.P.	$31^0$57’35.9”N $77^0$07’21.8”E
	Necrodes	*Necrodes littoralis*	18-vi-2014	Gagret, H.P.	$31^0$66’23.11”N $76^0$06’93.86”E
			15-vi-2015	Kullu, H.P.	$31^0$57’35.9”N $77^0$07’21.8”E
		Necrodes nigricornis	20-ix-2014	Gagret, H.P.	$31^0$66’23.11”N $76^0$06’93.86”E
	Thanatophilus	*Thanatophilus Minutus*	25-v-2014	Kullu, H.P.	$31^0$57’35.9”N $77^0$07’21.8”E
Nicrophorinae	Nicrophorus	*Nicrophorus nepalensis*	29-v-2015	Kullu, H.P.	$31^0$57’35.9”N $77^0$07’21.8”E


5


6


7

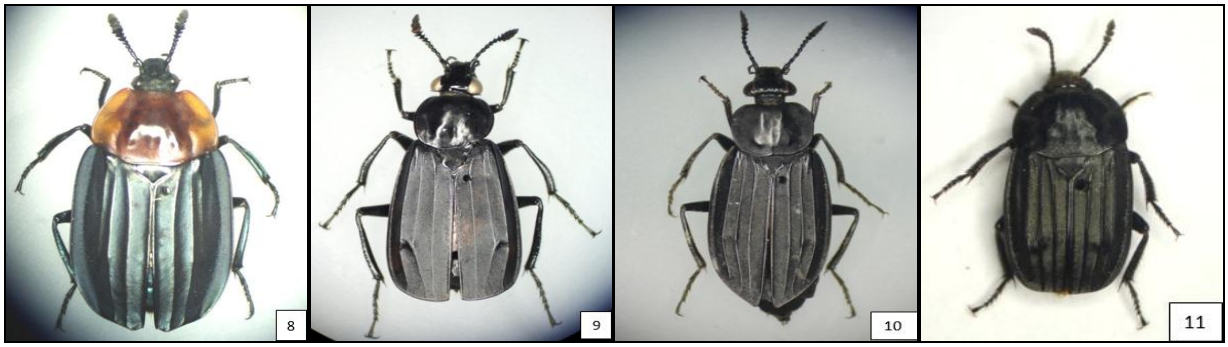

Fig 5-11: Adults of *Nicrophorus nepalensis*; *Necrophila ioptera*; *Necrophila* (*Deutosilpha*) *rufithorax*; *Necrophila* (*Calosilpha*) *cyaniventris*; *Necrodes littoralis*; *Necrodes nigricornis*; *Thanatophilus minutus*

Fig 12-13: Satellite view of Gharakar (Kullu, H.P.) and Gagret (Una, H.P.) India with plotted coordinates (Google Maps-17/10/2015)

Discussion

All the carrion beetles do not have the same forensic interest; species of Silphinae seem to have more important value as forensic bioindicators (Matuszewski *et al*. 2010) [12]. Indeed they have ecological preferences for small vertebrate carcasses, while Nicrophorinae present less interest in forensic entomology (Watson *et al*. 2005) [33] although they are frequently present on human corpses. In some cases, necrophagous beetles provide information on the presence of drugs or poisons by bioaccumulation (Introna *et al*. 2001) [10]. When a corpse is colonized by the insects there are generally two situations; first where PMI is estimated by determining the age of oldest specimen found on the body or death scene, principally blowflies and second where necrophagous species colonize the corpse with a delay, often after the departure of pioneer species (Amendt *et al*. 2007) [1]. The estimation of the PMI is only possible by analyzing the chronological succession (Lefebvre & Gaudry 2009) [11]. Flies locate the corpses faster than beetles and that is the main reason why they are used in forensic investigations and beetles are generally ignored. Silphidae is generally the first ones among beetles to reach the corpse. Recent observations (Midgley & Villet 2009) [16] have shown that *Thanatophilus micans* (Silphidae) can locate corpses and start breeding within 24 h of death, and thus the potential utility of estimates based on this species is equal to that of those based on flies (Midgley *et al*. 2010) [17]. In the case of late arriving insects such as beetles PAI (pre-appearance interval) may constitute the majority of an interval that elapsed from death where PAI is an interval that precedes the appearance of a taxon on a carcass (Matuszewski 2011) [13] Therefore, while estimating postmortem interval (PMI) from entomological evidence, and in particular from evidence related to late-arriving insects, it is necessary to determine PAI in some way (Matuszewski & Szafalowicz 2013) [14]. Matuszewski (2011; 2012) [13, 14] estimated the PAI of carrion insects i.e. *Necrodes littoralis* and *Creophilus maxillosus* from temperature for the PMI estimation. Silphids and principally burying beetles are widely studied in biology and ecology but are poorly studied in forensic context. There ought to be more formative models of insect species alongside their progression data and nature.

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