Journal of Pharmacognosy and Phytochemistry

Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
JPP 2018; 7(6): 1581-1590
Received: 16-09-2018
Accepted: 18-10-2018

Phunu Mili
Department of Entomology, Assam Agricultural University, Jorhat, Assam, India

Anjumoni Devee
Department of Entomology, Assam Agricultural University, Jorhat, Assam, India

Dilip Kumar Saikia
Department of Entomology, Assam Agricultural University, Jorhat, Assam, India

Correspondence
Phunu Mili
Department of Entomology, Assam Agricultural University, Jorhat, Assam, India

Carabid beetles collected from vegetable ecosystem

Phunu Mili, Anjumoni Devee and Dilip Kumar Saikia

Abstract
The work on 'Carabid complex of horticultural orchards' was conducted in the Experimental Farm, Department of Horticulture, Assam Agricultural University, Jorhat-13, during the year 2014-2015 and 2015-16 to give a comprehensive information of carabids found in horticultural crops. Carabids were collected by pitfall trap, light trap, sweep net and hand picking from okra, brinjal, cabbage, cucumber and bean. Total 12 species of carabids belonging to 7 genera *viz.*, *Clivina*, *Scarites*, *Harpalus*, *Pherosophus*, *Pterostichus*, *Chlaenius*, and *Sparostes* under 6 tribes- Clivinini, Scaritini, Harpalini, Brachinini, Pterostichini and Chlaeniini and 5 subfamily (Scaritinae, Harpalinae, Brachininae, Pterostichinae and Licininae) were identified by following published Keys and literature and described on the basis of observed morphological characters. Among these species, 3 under *Clivina viz.*, *C. assamensis*, *C. memnonia*, *C. lobata* and 2 under *Scarites*, *Harpalus* and *Pherosophus* each *viz.*, *S. indus*, *S. inconspicuous*, *H. rufipes*, *H. calceatus*, *P. occipitalis* and *Pherosophus* sp. From *Pterostichus*, *Chlaenius* and *Sparostes*, there was one species of each genus *viz.*, *Pterostichus madidus*, *C. bimaculatus* and *Sparostes striatulus*. Highest collection of carabids were obtained from pitfall trap (46%) followed by light trap (42%). Total 249 numbers of carabids were collected from Jan-Dec, 2015. The species richness, species diversity and species evenness were highest in okra (2.918, 2.782 and 1.054, respectively). Among all the species, *S. indus*, *C. assamensis* and *S. inconspicuous* were relatively more abundant species. The present study may help in proper identification of different carabid species of Assam for future studies and the dominant species can be incorporated in future Integrated Pest Management programme as natural pest control agent.

Keywords: Carabidae, species richness, species diversity, species evenness, pitfall trap, light trap.

1. Introduction
Carabids or ground beetle are one of the important natural biocontrol agents in agro-ecosystem and good indicators of environmental change. Usually carabids are predators while some species are omnivorous, some phytophagous and most of them are carnivorous [6].Carabids are one of the largest and most successful order under coleoptera with over 40,000 species [7]. They are considered to be mostly opportunistic feeders that consume a variety of foods. Carabids most active and numerous, and able efficiently reduce populations of some pest mites, pest insects: aphids, thrips, coleopterans, sawflies, cicadas, dipterous, and some arthropods such as springtails and slugs [11].
Carabids employ a wide variety of ecological strategies. The carabid beetles are appropriate organisms for ecological quality assessments. Carabids show clear associations with environmental parameters such as soil type and vegetation cover; thus they are good indicators of environmental change. The abundance, species richness and attractive coloration of many species have made carabids popular objects of studies for entomologists [8]. Carabids are relatively long-lived animals and could be sampled by using pitfall traps. All of these issues make carabids suitable organisms for assessing microhabitat selection or seasonality on small spatio-temporal scales. Moreover, environmental changes make it relevant to have a more precise understanding of the spatial and temporal variation in the seasonal dynamics of carabids. However, sometimes the classical elements of species attributes such as life-history characteristics provide clues for conservation of biodiversity. In Assam, there is no detail report regarding the availability of carabids associated with horticultural ecosystem. The first record of carabid from Assam was found in 'Fauna of British India' (1929) with *Clivina*, *Scarites*, *Coryza* and *Oxygnathus* genus. Therefore, the present investigation on diversity of carabids was undertaken to know the status of carabids in vegetable ecosystem.

2. Materials and Methods
The present investigation was conducted in the Experimental Farm, Department of Horticulture, Assam Agricultural University, Jorhat during the year 2014 - 2015 and 2015 -

2016. The farm is situated at $94^0$12'E Longitude and $24^0$47'N Latitude, and at an altitude of 86.8 meters above mean sea level. The total area of the farm is 16.62 ha.

Beetles were collected by pitfall trap, light trap and hand collection. Pitfall traps of 500 ml (11.5 cm diameter, 9 cm deep) were placed randomly in the horticultural orchard (approx. 5 m^2 distance). Traps were filled with preservative (200 ml 95% labolene) and replaced after 48 hours [2]. The traps were active for 48 hours and these were changed at weekly intervals. Beetles collected in light traps and with hand collection were killed immediate by using ethyl acetate either in the killing bottle or by introducing cotton balls dipped into ethyl acetate in closed polythene bags. After killing, the beetles were pinned/cardened, stretched in an insect box. The collected carabid beetles were observed under Stemi 2000-C and MS 24 microscope in the laboratory and measurements were taken by using scale.

Collected specimens of carabids were preserved with proper labeling comprised of date and crop associated. The specimens were identified by following published Keys and literature, Fauna of British India (1929), Zoological Survey of India (1992), Handbooks for the identification of British insects (1992), Key and Catalogue of the tribe Clivinini from the Oriental realm: with revisions of the genera Thliboclivina (2001), Keys for identification of the British Carabidae (1974) and described on the basis of observed morphological characters *viz.*, shape, size, markings spots, setose etc. present in different body parts (head antennae, thorax, abdomen, mouth parts etc). The specimens were confirmed by Dr. (Mrs.) Chitra Srivastava, Head & Principal Scientist, Dept. of Entomology, IARI, New Delhi.

The relative abundance of each species was determined using the formula [3]:

$$\text{Relative Abundance (RA) of a species} = \frac{\text{No.of individuals of the species}}{\text{No.individuals of all species}} \text{ X } 100$$

The species richness is calculated by using Margalef index (R), R = S-1/ln(n)

Where,

S = number of species
n = total number of individuals of all the species
ln = natural logarithm

Diversity indices is calculated by computing Shannon-Weiner index of diversity

Shannon-Weiner index (H') = $- \sum (p_i \ln p_i)$

Where,

p_i = proportion of i^{th} species in the total sample
$p_i = n_i/N$
n_i= number of individuals of i^{th} species
N = total number of indivduals)
n = natural logarithm (loge)

Evenness indices is calculated by using Kreb's formula

$$E = \frac{H}{H' max}$$

Where,

H'_{max} = natural logarithm of the number of species present

$0 < E \leq 1$, the maximum value being possible in a community in which all the species are equally abundant.

The statistical analysis of the collected specimens was done by the above mentioned formula and from the calculated data, mean and standard deviation was calculated.

3. Results and Discussion

***Clivina assamensis* Putzeys, 1846 (Fig 1: A-F)**

Sub-family: Scaritinae Bonelli, 1810

Tribe: Clivinini Rafinasque, 1815

Sub-tribe: Clivinina Kult, 1947

10 x A | B | 10 x C | 10 x D | 10 x E | F

Fig 1(A-F): *C. assamensis*: (A) - Dorsal; (B)- Sketch of dorsal side (C) - Ventral; (D) - Mesothorax constricted as neck between pronotum and elytra; (E, F) - Basal tarsomere forelegs with rows of numerous bristles and its sketch

Description: Adult

Generally black, oval, convex and sub cylindrical (Fig. 1 A, B,) but somewhat flattened species with mesothorax constricted as a "neck" between pronoun and elytra (Fig. 1 C, D). Head with one or two pairs of supraorbital setae, pronotum with or without small punctures. Basal tarsomere of front legs large, with rows of numerous bristles on dorsal surface (Fig. 1 E, F). Intervals of elytra without setaceous punctures. The present findings are similar with the findings of Andrews (1929) [1], Saha *et al.* (1992) [10] and Kushwaha *et al.* (2015) [5]. Body length, body breadth, length of head, inter ocular distance, length of pronotum, length of abdomen were 8.85 mm ± 0.264, 2.97 mm ± 0.170, 0.95 mm ± 0.129, 0.92 mm ± 0.170, 1.62 mm ± 0.15, 6.17 mm ± 0.309, respectively and these were similar with the findings of Andrewes (1929) who reported that the body length of *C. assamensis* was 9 mm and 6.3-9 mm respectively.

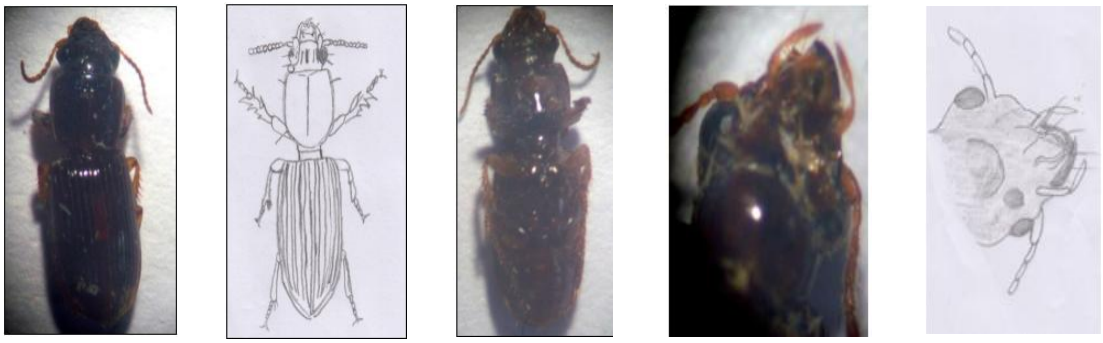
***Clivina memnonia* Dejean, 1831 (Fig 2: A-E)**

Synonyms: *Clivina indica* (Putzeys, 1875), *Clivina rugosifrons* (Nietner, 1856), *Clivina recta* (Walker, 1858)

Sub-family: Scaritinae, 1815

Tribe: Clivinini, Rafinasque, 1815

Sub-tribe: Clivinina, Rafinasque, 1815



10x A | B | 10x C | 10x D | E

Fig 2(A-E): *C. memnonia*; (A) - Dorsal; (B) - Sketch of dorsal side (C) - Ventral; (D) - 6 Setose; (E) - Sketch of 6 setose

Description: Adult

Head, pronotum and elytra dark brown, labrum, antennae, legs reddish brown (Fig. 2 A, B, C). Eyes large and convex, deep pit present on head, antennae short and monili form, nearly smooth, only a row of punctures on the vertex. Presence of large elongate pore on middle of vertex. Pronotum convex, sub quadrate, glabrous, median line prominent. Presence of 6-setose in the labrum (Fig. 2 D, E), mentum with a shallow sinus and a rounded tooth, neck constricted slightly interrupted at middle. Elytra elongate, striae deep and crenulate. Body length, body breadth, length of head, inter ocular distance, length of pronotum, length of abdomen were 6.55 mm ± 0.208, 2.85 mm ± 0.129, 0.72 mm ± 0.095, 0.72 mm ± 0.15, 1.55 mm ± 0.129, 4.02 mm ± 0.262, respectively. These findings are in conformity with the findings of Andrewes (1929) [1], and Saha *et al.* (1992) [10] and they reported 6-setose in the labrum and also reported that body length of *C. memnonia* varied from 6.5-11 mm.

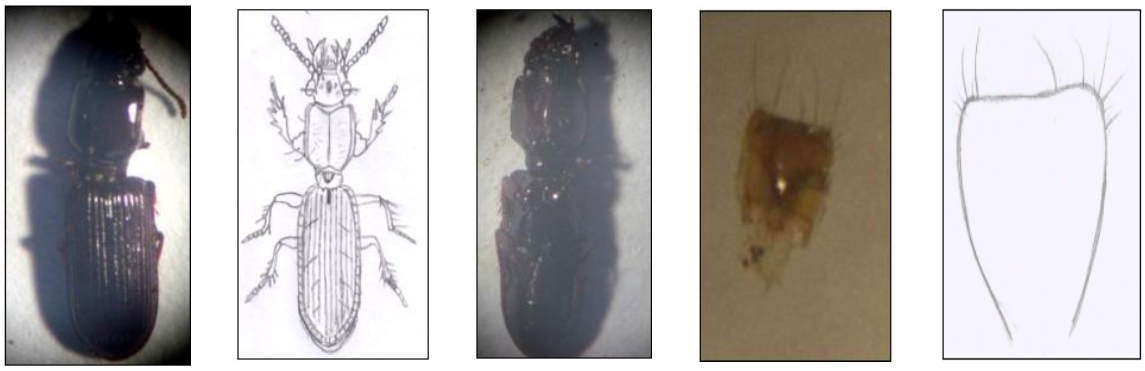
***Clivina lobata* Bonelli, 1813 (Fig3: A-E)**

Synonyms: *Clivina anceps* (Putzeys), *Clivina hydropica* (Putzeys), *Clivina angularis* (Putzeys, 1892), *Clivina capitata* (Putzeys), *Clivina divaricata* (Putzeys), *Clivina laviceps* (Bates, 1892).

Sub-family: Scaritinae, 1815

Tribe: Clivinini, Rafinasque, 1815

Sub-tribe: Clivinina, Rafinasque, 1815



10x A | B | 10x C | 10x D | E

Fig 3 (A - E): *C. lobata*; (A) - Dorsal; (B) - Sketch of dorsal side; (C) - Vental side (D) - setose; (E) - Sketch of setose

Description: Adult

Adults dark brown, labrum, antennae, legs reddish brown (Fig. 3 A, B, C). Eyes large and convex, deep pit present on head, antennae short and monili form, nearly smooth, pore on the vertex. Presence of 7-setose in the labrum (Fig. 3 D, E), neck constriction slightly, minutely punctate. Presence of pore on vertex. Pronotum moderately convex, quadrate, glabrous, sides margined median line prominent. Elytra moderately convex, quadrate, striae fairly and minutely punctate, intervals moderately convex. Body length, body breadth, length of head, inter ocular distance, length of pronotum, length of abdomen were 6.05 mm ± 0.208, 2.92 mm ± 0.170, 0.82 mm ± 0.095, 0.8 mm ± 0.81, 1.47 mm ± 0.095, 3.72 mm ± 0.359, respectively and these findings corroborated the findings Andrewes (1929) [1] and Saha *et al.* (1992) [10] who reported that the body length of *C. lobata* varied from 4-7mm and 5-6mm, respectively and had 7 setose on labrum.

Table 1: Comparison between different species of *Clivina*

Characters	*C. assamensis*	*C. memnonia*	*C. lobata*
Colour	Black	Black, middle and hind legs dark red	Dark brown; antennae, labrum and leg reddish brown
Labrum Body length Elytral striae	6 setose 8.85mm ± 0.264 Not so deep	6-setose 6.55±0.208mm Deep, crenulate	7-setose 6.05±0.208mm Fairly deep and punctate Pore on vertex
Vertex pore	No pore	Large elongate pore on middle of the vertex	
Prothorax	Convex, subquadarte	Convex, subquadarte	Moderately convex, quadrate
Leg	Basal tarsomere of front legs large, with rows of numerous bristles on dorsal surface	Protibiae finely sulcate, 4-denticulate, mesotibiae densely fringed	Protibiae sulcate, small upper tooth, mesotibiae with long bristles

***Scarites (Parallelomorphus) indus* Oliver, 1795 (Fig 4: A-E)**
Synonyms: *Scarite smancus* (Bonelli, 1813), *Scarites terricola* (Andrews, 1921)

Sub-familiy: Scaritinae Bonelli, 1810
Tribe: Scaritini Bonelli, 1810
Sub-tribe: Scaritina Bonelli, 1810

10x A | 10x B | 10x C | 10x D | 10x E

Fig 4 (A - E): *S. indus*; (A) - Dorsal; (b) - Sketch of dorsal side; (C) - Ventral; (D) - Bidentate mandibles; (E) - Sketch of bidentate mandibles

Description: Adult
Head, pronotum, elytra, mandible, labrum, clypeus black; whereas palpi, antennae and legs deep reddish black (Fig. 4 A, B, C). Mandibles bidentate (Fig. 4 D, E) Head with lateral projection. Eyes small and lateral. Pronotum little wider, apex less emerginate. Elytra with more rounded sides, striate shallower and lightly punctate. Body length, body breadth, length of head, inter ocular distance, length of pronotum, length of abdomen were 22.5 mm ± 0.129, 7.95 mm ± 0.129, 4.32 mm ± 0.170, 3.95 mm ± 0.129, 4.62 mm ± 0.298, 13.75 mm ± 0.208, respectively. Andrewes (1929) [1] and Saha *et al.* (1992) [10] reported that the body length of *S. indus* collected from Assam was 16-22 mm and from Calcutta was 19 mm, respectively.

***Scarites inconspicuous* (Fig 5: A - F)**
Sub-family: Scaritinae Bonelli, 1810
Tribe: Scaritini Bonelli, 1810
Sub-tribe: Scaritina Bonelli, 1810

10x A | B | 10x C | 10x D | 10x E | F

Fig 5 (A-F): *S. inconspicuous*; (A) - Dorsal; (B) - Sketch of dorsal side; (C) - Ventral; (D) - Prothorax; (E, F) - Protibia and mesotibia with 2 or 3 dentriculation and with 2 spurs, respectively

Description Adult: Adults, black (Fig. 5 A, B, C) with lateral truncature straight, neck slightly constricted at sides and faintly punctate. Prothorax fifth wider than head (Fig. 5 D) and as much wider as long. Elytra very slightly dilated behind, about as wide as prothorax, sides of base curving gently backwards to shoulders; striae deep. Protibiae with 2 or 3 denticulations above upper tooth; mesotibiae with two sharp spurs, the upper shorter than the lower one (Fig. 5 E, F). Body length, body breadth, length of head, inter ocular distance, length of pronotum, length of abdomen were 18.17 mm ± 0.275, 5.97 mm ± 0.170, 2.95 mm ± 0.129, 3.3 mm ± 0.216, 4.1 mm ± 0.130, 10.72 mm ± 0.660, respectively. These findings are in conformity with the findings of Andrewes (1929) [1], who observed the similar type of characters for *S. inconspicuous*. He reported that the body length of *S. inconspicuous* varied from 18-21 mm.

Table 2: Comparison between different species of *Scarites*

Characters	*Scarites indus*	*Scarites inconspicuous*
Head	Lateral projection therefore more conspicuous	Lateral truncature straight, no lateral projection therefore inconspicuous
Body length	22.5±0.129mm	
Elytral striae	Shallow	18.17±0.275mm Deep
Prothorax	Little wider, apex less emarginate	Wider than head

***Harpalus (pseudoophonus) calceatus* Duftschmid, 1812 (Fig 6: A-E)**
Synonyms: *Harpalus calcitrapus* (Motschulsky, 1844), *Harpalus itoshimanus* (Habu, 1954), *Harpalus nonsignatus* (Krynicki, 1832), *Ophonus calceatus*, *Pseudoophonus calceatus* (Duftschmid, 1812)

Sub-family: Harpalinae, Bonelli, 1810
Tribe: Harpalini Bonelli, 1810
Sub-tribe: Harpalina Bonelli, 1810

10x A | B | 10x C | 10x D | E

Fig 6(A - E): *H. calceatus*; (A) - Dorsal; (B) - Sketch of dorsal side; (C) - Ventral; (D, E): Pronotum with punctures

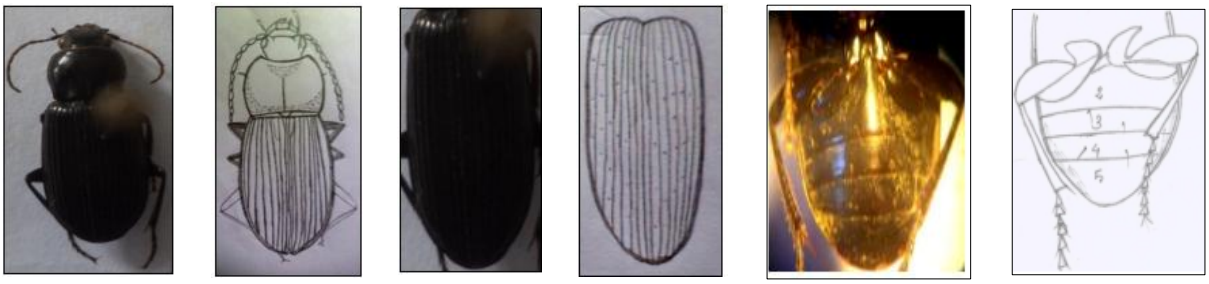
Description: Adult

Adults were black with extreme sides of pronotum, antannae and legs were paler (Fig.6 A, B, C). Tarsi with short hairs on the upper surface. Third elytral interval without a dorsal puncture. Base of pronotum with large punctures (Fig.6 D, E) that run into one another. Eighth and ninth elytral intervals with very fine pubescence. Similar observations were also reported by Hackston (2014) [4]. Body length, body breadth, length of head, inter ocular distance, length of pronotum, length of abdomen were 12.07 mm ± 0.221, 5.97 mm ± 0.170, 1.97 mm ± 0.221, 1.67 mm ± 0.170, 2.82 mm ± 0.172, 7.02 mm ± 0.125, respectively.

***Harpalus rufipes* De Geer, 1774 (Fig7: A - F)**

Synonyms: *Carabus rufipes* (De Geer, 1774), *Pseudophonus pubescens* (O.F. Muller, 1776), *Carabus pubescens* (O.F. Muller, 1776), *Carabus ruficornis* (Fabricius, 1775).

Sub-family: Harpalinae Bonelli, 1810
Tribe: Harpalini Bonelli, 1810
Sub-tribe: Harpalina Bonelli, 1810



10x A | B | 10x C | D | 10x E | f

Fig 7(A - F): *H. rufipes*; (A) - Dorsal; (B) - Sketch of dorsal side; (C) - Elytra with punctures; (D)- Sketch of elytra with punctures; (E, F)- Last three abdominal segments have punctures and hairs towards the sides

Description: Adult

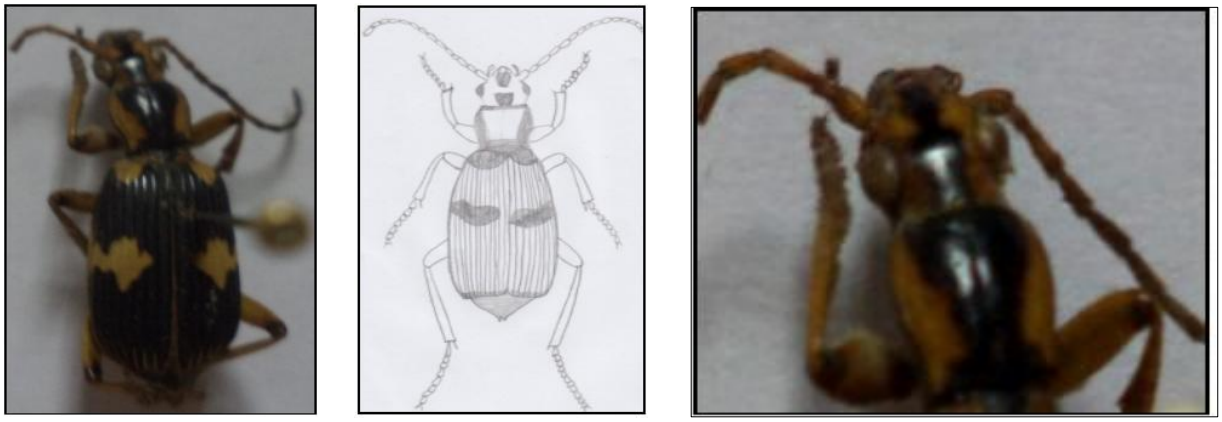
Adults were black (Fig.7 A, B) and all intervals of the elytra with punctures (Fig.7 C, D). On the underside, the last three abdominal segments have punctures and hairs towards the sides (Fig.7 E, F), but were smooth and hairless in the middle. Pronotum with the sides slightly curving inwards just short of the hind angles, which therefore look sharper. Similar observations were also reported by Hackston (2014)[4]. The body length, body breadth, length of head, inter ocular distance, length of pronotum, length of abdomen were 15.1 mm ± 0.258, 6.85 mm ± 0.264, 2.37 mm ± 0.170, 1.9 mm ± 0.182, 2.95 mm ± 0.129, 9.52 mm ± 0.441, respectively.

Table 3: Comparison between different species of *Harpalus*

Characters	*Harpalus rufipes*	*Harpalus calceatus*
Colour	Complete black	Black with extreme sides of sides of pronotum, antennae and legs paler 12.07mm±0.221
Body length	15.1mm±0.258	Third elytral intervals without punctures
Elytral striae	All intervals of elytra with puncture	Base with large punctures
Prothorax	Sides slightly curving inwards	

***Pherosophus (stenaptinus) occipitalis* W.S. Macleay, 1825 (Fig 8: A-F)**

Sub-family: Brachininae Bonelli, 1810
Tribe: Brachinini, Bonelli, 1810



10X 10X
A B C

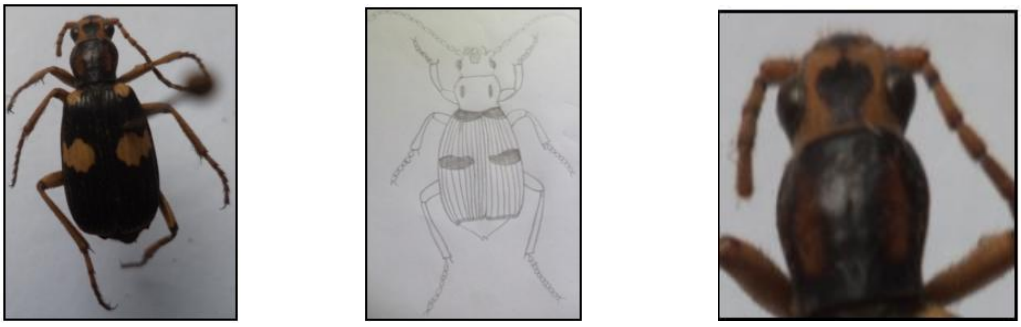
Fig 8(A - F): *P. occipitalis*; (A) - Dorsal; (B) - Sketch of dorsal side; (C) - Pronotum

Morphological characters

Adults were moderately large and elongate. Head brown with rectangular black patch on vertex and one elongate black patch on front (Fig 8. A, B). Eyes brown, palpi and mandible deep brown, antennae filiform, rest hairy and deep brown. Pronotum black but with two brown elongate patches to the lateral sides of the posterior part (Fig 8. C). Elytra black with one pair of brown patch on the base of elytra near the humeral angles and the other elongate brown patch on the sides of lateral margin centrally. The body length, body breadth, length of head, inter ocular distance, length of pronotum, length of abdomen were 16.85 mm ± 0.310, 7.9 mm ± 0.182, 3.95 mm ± 0.129, 1.6 mm ± 0.141, 3.2 mm ± 0.163, 9.57 mm ± 0.377, respectively. In 1992, Saha *et al.* found the same findings and reported the body length varied from 16-18 mm.

***Pherosophus* sp. (Fig 9: A-C)**

Sub-family: Brachininae Bonelli, 1810
Tribe: Brachinini, Bonelli, 1810



10X 10X
A B C

Fig 9 (A - C): *Pherosopus* sp.; (A) - Dorsal; (B) - Sketch of dorsal side; (C) – Pronotum

Morphological characters

Adults were moderately large and elongate. Head brown with black patch on vertex and one small black patch on front (Fig A, B). Eyes black, palpi and mandible deep brown, antennae filiform, rest hairy and deep brown. Pronotum black but with two narrow brown elongate spots (Fig C). Elytra black with one pair of brown patch. On the base of elytra near the humeral angles and the other elongate brown patch on the sides of lateral margin centrally. The body length, body breadth, length of head, inter ocular distance, length of pronotum, length of abdomen were 14.95 mm ± 0.184, 6.56 mm ± 0.315, 2.75 mm ± 0.146, 1.4 mm ± 0.129, 2.9 mm ± 0.375, 9.4 mm ± 0.165, respectively. In 1992, Saha *et al.* found the same findings and reported the body length varied from 14-18 mm.

Table 4: Comparative differences of different *Pherosophus* spp.

Characters	*P. occipitalis*	*Pherosophus* sp.
Eyes	Brown	Black
Body length	16.85±0.310	14.95±0.184
Pronotum	Pronotum black but with two brown elongate patches to the lateral sides of the posterior part	Pronotum black but with two narrow brown elongate spots

***Pterostichus madidus* Bonelli, 1810 (Fig. 9 A-E)**

Sub-family: Pterostichinae Bonelli, 1810
Tribe: Pterostichini Bonelli, 1810
Sub-tribe: Pterostichina sensu stricto

10X A | B | 10X C | 10X D | E

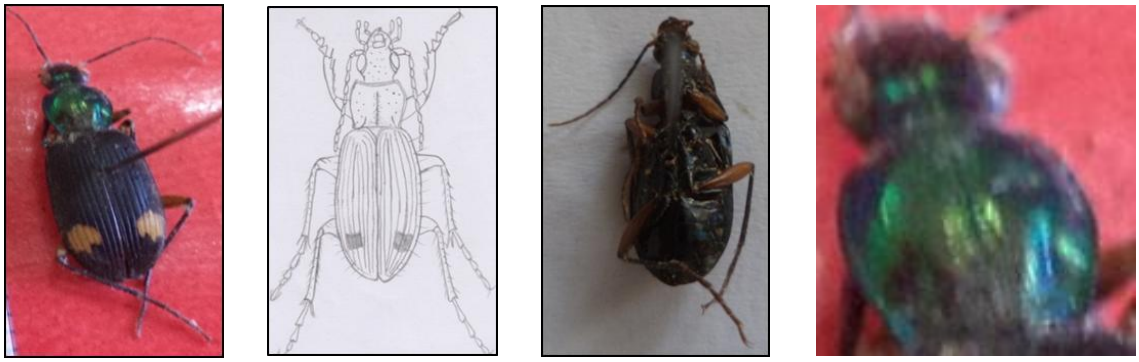
Fig 9(A - E): *P. madidus*; (A) - Dorsal; (B) - Sketch of dorsal side; (C) - Ventral side; (D, E) - Pronotum

Morphological characters

Beetles were complete black varying considerably in size, of a somewhat stout appearance pronotum only slightly narrower than elytra (Fig 9. A, B, C). The legs are rather long but with heavy tibiae; claws simple. Pronotum with a single or double latoro-basal fovea (Fig 9. D, E). Third elytra interval with at least one dorsal puncture. The body length, body breadth, length of head, inter ocular distance, length of pronotum, length of abdomen were 15.92 mm ± 0.221, 6.9 mm ± 0.216, 1.95 mm ± 0.129, 2.17 mm ± 0.095, 3.52 mm ± 0.125, 10.45 mm ± 0.275, respectively. These findings were similar with the findings of Hackston (2014) [4] he also reported that the body length of *P. madidus* varied from 23-17 mm.

***Chlaenius (Lissauchenius) bimaculatus* Dejean, 1826 (Fig. 10 A-D)**

Sub-family: Licininae Bonelli, 1810
Tribe: Chlaeniini Brulle, 1834
Sub-tribe: Chlaeniina Brulle, 1834



10X A | B | 10X C | 10X D

Fig 10(A - D): *C. bimaculatus*; (A) - Dorsal; (B) - Sketch of dorsal side; (C) - Ventral side; (D, E) – Pronotum

Morphological characters

Characterised by the medium to large size, elongate-oval. Head and pronotum dark metallic bronze-green or blue-green with reddish reflection (Fig 10. D), elytra obscure black; with two large yellowish brown spots (Fig 10. A, B, C). Head convex, slightly wider than long, legs wholly reddish brown, femur yellowish brown and apex of femur, tibiae, tarsi and trochanters brown or dark brown. The body length, body breadth, length of head, inter ocular distance, length of pronotum, length of abdomen were 14.5 mm ± 1.290, 5.95 mm ± 0.208, 2.07 mm ± 0.170, 1.12 mm ± 0.095, 3.07 mm ± 0.170, 9.55 mm ± 0.288 respectively. These findings were similar with the findings of Saha and Sengupta (1979)[9] who reported that the body length of *C. bimaculatus* varied from 12.7 -14 mm.

***Sparostes striatulus* Putzeys, 1867 (Fig. 11 A - E)**

Sub-family: Scaritinae Bonelli, 1810
Tribe: Clivinini Rafinasque, 1815
Sub-tribe: Clivinina Rafinasque, 1815

10x A | B | 10x C | 10x D | E

Fig 11(A - E): *S. striatulus*; (A) - Dorsal; (B) - Sketch of dorsal side; (C) - Ventral; (D, E): Striae finely punctate.

Description: Adult

Adults black in colour (Fig.11 A, B). Head narrower than prothorax, elytra elongate, base truncate. Elytra as wide as prothorax and twice as long as wide, rather sharply rounded at apex. Striae rather fine and finely punctate (Fig.11 D, E). Body length, body breadth, length of head, inter ocular distance, length of pronotum, length of abdomen were 22.57 mm ± 1.260, 6.95 mm ± 0.129, 3.77 mm ± 0.221, 3.5 mm ± 0.141, 4.95 mm ± 0.129, 13.85 mm ± 0.853, respectively. These findings are similar with the findings of Andrewes (1929)[1] who reported that striae rather finely punctate, 1 to 5 free at base, 6 and 7 joining at the shoulder, the length of *S. striatulus* varied from 16-22 mm.

4.3.1. Monthly distribution of different carabids

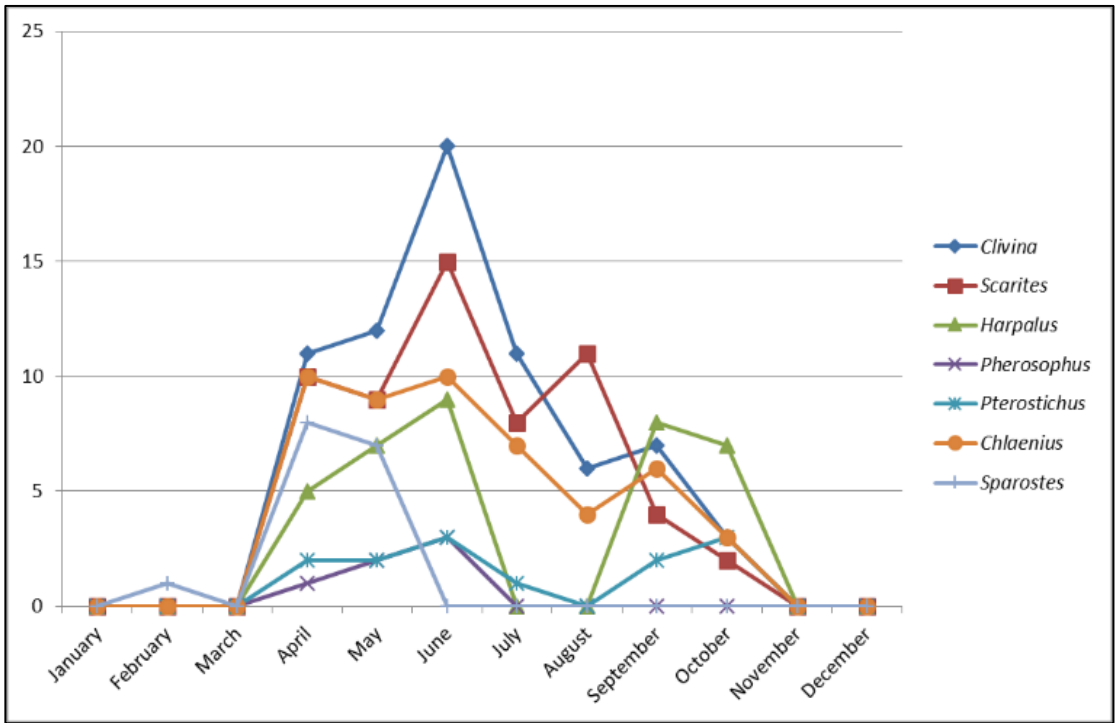


Fig 1: Monthly distribution of different genus of carabids

The monthly occurence of different carabid beetles were recorded in the Experimental Farm, Department of Horticulture, Assam Agricultural University, Jorhat. Regular collection of beetles were made at weekly interval from January' 2015 to December 2015 to ascertain the presence of adult beetles at ten different study plots of 100 square meter area. The initial appearence of carabids were observed in February. The peak activity of carabids was recorded during June' 2015 with 60 number of total collection followed by May' 2015 with 48 number of total collection. The population of carabid was found up to October' 2015. During November-December' 2015, no carabid beetles were recorded in different survey plots. While the activity of genus *Sparostes* was observed from February.

4.3.2 Distribution of carabids in different crops

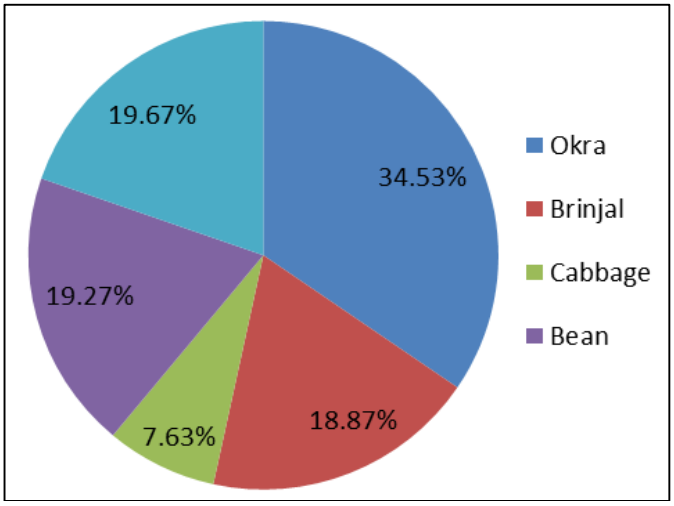


Fig 2: Distribution of carabids in different crops

The number of carabid beetles collected from different crops grown in the Experimental Farm, Assam Agricultural University, Jorhat, revealed that the highest collection was from okra (34.53%) followed by Cucumber (19.67%), Bean (19.27%), Brinjal (18.87%) and from cabbage (7.63%).

4.3.3. Trap wise collection of carabids

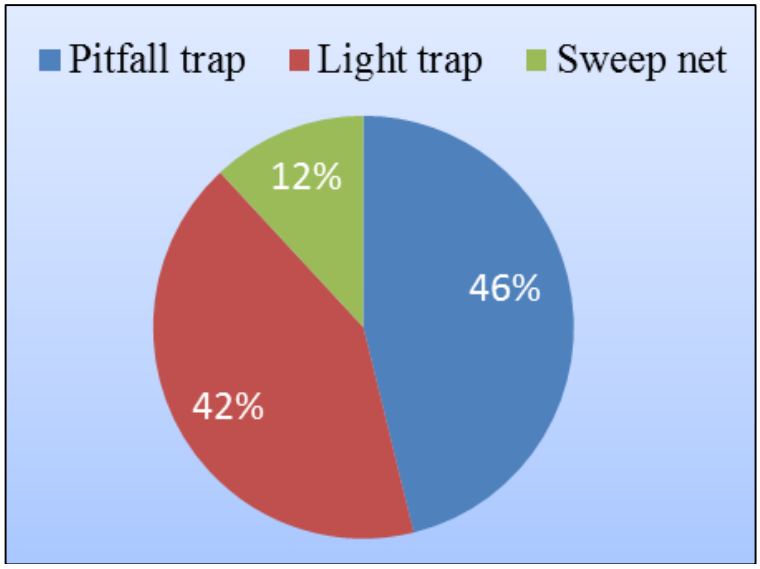


Fig 3: Carabid collections in different traps

Among different types of traps used for collection of carabids, the highest collection of carabids were obtained from pitfall trap (46%), followed by light trap (42%) and sweep net (12%) during January-December' 2015.

4.3.4. Relative abundance of carabids

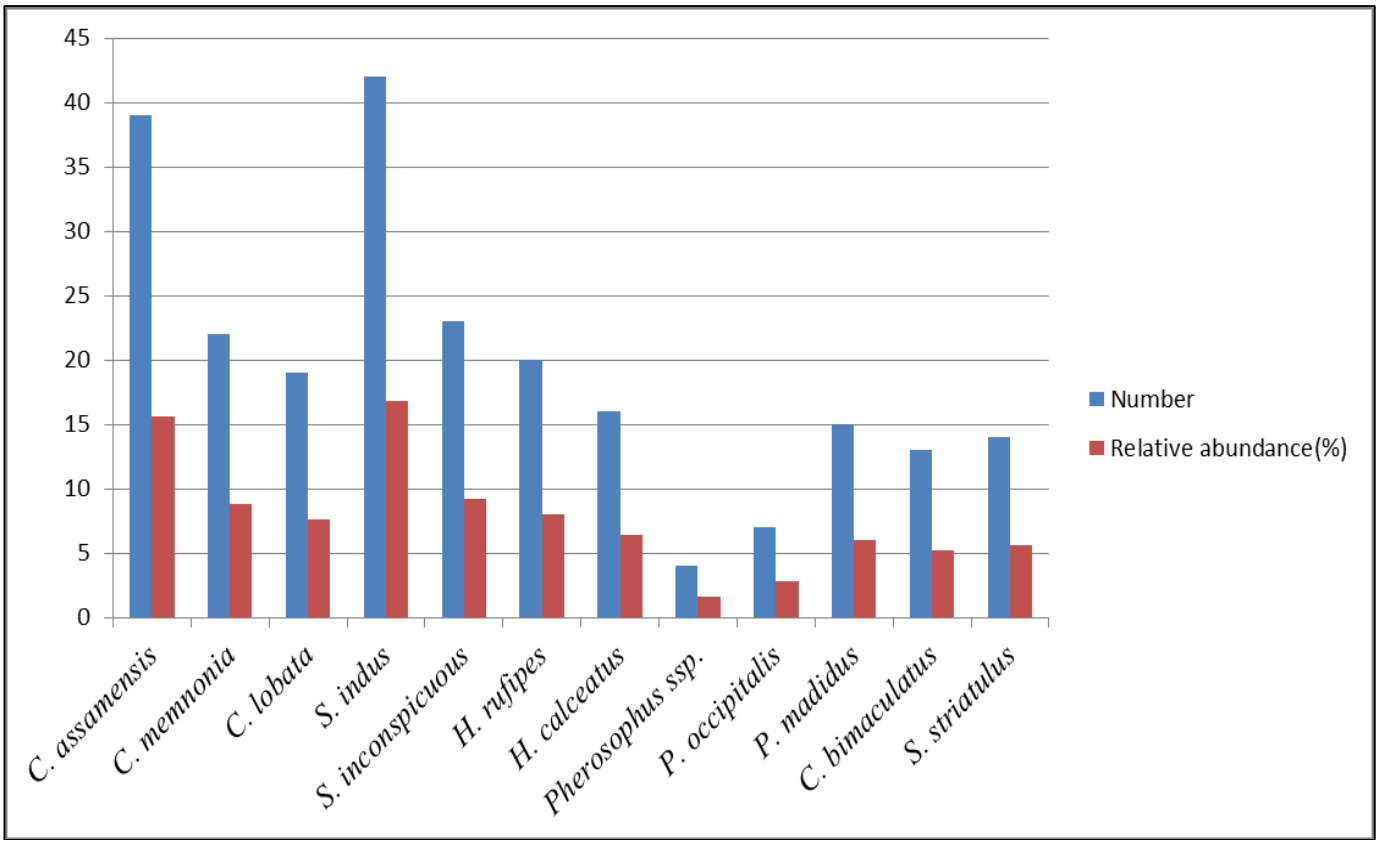


Fig 4: Relative abundance of carabids

The above figure shows the relative abundance of various carabid species. *S. Indus* (16.86%) was the highly abundant species followed by *C. assamensis* (15.66%), *S. inconspicuous* (9.23%), *C. memnonia* (8.83%), *H. rufipes* (8.03%), *C. lobata* (7.63%), *H. calceatus* (6.42%), *P. madidus* (6.02%), *S. striatulus* (5.62%), *C. bimaculatus* (5.22%), *P. occipitalis* (2.81%), and *Pherosophus* sp. (1.60%) was the relatively less abundant species.

Table 5: Diversity indices of carabids

Crop	Species richness	Species diversity	Evenness
Okra	2.918	2.782	1.054
Brinjal	1.818	1.52	0.730
Cabbage	1.358	1.104	0.685
Bean	0.774	1.449	1.045
Cucumber	2.312	1.720	0.746

Fig. Diversity indices of carabids

Diversity indices of carabids were calculated by using the formulas given by Margalef index and Shannon-Weiner index. Species richness was highest in Okra (2.918), followed by Cucumber (2.312), Brinjal (1.818), Cabbage (1.358), and Bean (0.774). Species diversity was highest in case of Okra (2.782), followed by Cucumber (1.72) Brinjal (1.52), Bean (1.449) and Cabbage (1.104). Evenness was highest in Okra (1.054) followed by Bean (1.045), Cucumber (0.746), Brinjal (0.730), and Cabbage (0.685). Among all the crops okra registered highest species richness, species diversity along with evenness.

4. Conclusion

The present study found 12 species under the genus *Clivina*, *Scarites*, *Harpalus*, *Pherosophus*, *Pterostichus*, *Chlaenius*, and *Sparostes* and among these genus *Harpalus* and *Sparostes* are reported for the first time from Assam. The present study may help in proper identification of different carabid species of Assam for future studies and the dominant species can be incorporated in future Integrated Pest Management programme as biological pest control agent. Also aid in preparation of checklist of different carabid species of different agro-ecosystem in Assam and their distribution map.

5. Acknowledgement

Authors acknowledge the help rendered by Dr. (Mrs.) Chitra Srivastava, Head & Principal Scientist, dept. of Entomology, IARI, New Delhi, for the identification of the insect mentioned in the paper

6. References

1. Andrewes HE. The Fauna of British India including Ceylon & Burma (Coleoptera, Carabidae), Carabinae. 1929; 1:1-383.
2. Ellsbury MM, Powell JE, Forcella F, Woodson WD, Clay SA, Riedella WE. Diversity and Dominant Species of Ground Beetle Assamblages (Coleoptera: Carabidae) in Crop Rotation and Chemical Input Systems for the North Great Plains. Ann. Entomol. Soc. Am. 2010; 91(5):619-625.
3. Firoz M, Tara JS. Ground and darkling beetles (Coleoptera: Carabidae, Tenebrionidae) from Kargil, Jand K. The Bio scan. 2010; 5(4):573-577.
4. Hackston M. Handbooks for the identification of British insects, London: Royal Entomological Society. Adapted from Lindroth, 1974, 4(2).
5. Kushwaha RK, Hedge VD, Chandra K. Ground Beetles (Coleoptera: Carabidae) from Chhattisgarh, India. ZOO's PRINT, 2015, 30(1).
6. Lobl I, Smetana A. Catalogue of Palaertic Coleoptera. Archostemata-Myxophaga-Adephaga. Apollo Books. Stenstrup, Denmark, 2003; 1:819.
7. Lorenz W. Nomina Carabidarum – Directory of the Scientific Names of Ground Beetles (Insecta, Coleoptera "Geadephaga: Trachypachidae and Carabidae incl. Paussinae, Cicindelinae, Rhysodinae). Second edition. Tutzing, published by the author, 2005, 1-993.
8. Lovei G L and Sunderland K D. Ecology and behavior of ground beetles (Coleoptera: Carabidae). Ann. Rev. Entomol. 1996; 41:231-256.
9. Saha SK, Sengupta T. Aspect of intraspecific variation in *Chlaenius bimaculatus* Dejean (Carabidae: Chlaeniini: Coleoptera). Proc. Symp. zooi. Surv. India. 1979; 1:27-4.
10. Saha SK, Mukherjee AK, Sengupta T. Carabidae (Coleoptera: Insecta) of Calcutta. Rec. zool. Surv. India, 1992, 144.
11. Sunderland KD. The diet of some predatory arthropods in cereal crops. J Appl. Ecol. 1975; 12:507-515.