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DIVERSITY OF AQUATIC COLEOPTERA IN IRRIGATED RICE

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ABSTRACT

This study on the aquatic coleopteran diversity in rice revealed 24 species under 18 genera and 5 families in the irrigated rice ecosystem of Pandit Jawaharlal Nehru College of Agriculture and Research Institute (PAJANCOA & RI), Karaikal, Union Territory of Puducherry. The study was conducted during kharif 2019 and rabi 2019- 2020. *Berosus indicus* was the dominant species in both the seasons. Dytiscidae (47.89%) and Hydrophilidae (49.23%) were the abundant families. Species diversity was maximum in kharif 2019, while species richness was maximum during rabi 2019-2020. Dytiscidae exhibited a significant negative correlation with water temperature, while Gyrinidae, Hydrophilidae and Noteridae showed significant negative correlation with pH, electrical conductivity, air and water temperature, and positive significant one with relative humidity. Multiple linear regression indicated that all the physico-chemical characteristics together were responsible for significant variation on the occurrence of Dytiscidae (92%), Gyrinidae (51%), Hydrophilidae (60%) and Noteridae (59%).

Key words: Irrigated rice, aquatic Coleoptera, kharif, rabi, relative abundance, biodiversity indices, correlation, multiple regression, temperature, pH, Dytiscidae

Rice (*Oryza sativa* L.) is an important cereal crop of the world (Sharif et al., 2014). It is a major crop grown in Cauvery delta region including Karaikal district (tail end of Cauvery delta region), Union Territory of Puducherry. Irrigated rice fields have sufficient water during the entire growing season, which is highly suitable for aquatic insects to flourish with a strong food chain (Bambaradeniya et al., 2004). However, most of the studies on insect diversity in rice fields were focused on terrestrial insects (Jauharlina et al., 2019). The aquatic fauna of irrigated rice has been less studied (Kiritani, 2000). Yano et al. (1983) recorded 20 species of aquatic Coleoptera under 5 families in rice fields of Taiwan and Philippines. In India, Rai et al. (2000) recorded 368 species of Coleoptera in rice ecosystem, of which approximately 41 species were aquatic. Divya and Chitra (2019) furnished a global checklist of aquatic Coleoptera fauna in irrigated rice, which included 262 species of 110 genera under 17 families. This study revealed that it was dominated by Hydrophilidae (22 genera, 94 species) followed by Dytiscidae (40 and 90, respectively). Considering the importance of the coleopteran in ecosystem functioning as prey, predators, scavengers and bioindicators, it is essential to know the available aquatic coleopteran in rice ecosystem. Hence, the present study to record the diversity and abundance of aquatic coleopterans in irrigated rice ecosystem of PAJANCOA and RI, Karaikal in two seasons.

MATERIALS AND METHODS

The aquatic Coleoptera fauna of irrigated rice ecosystem at the Pandit Jawaharlal Nehru College of Agriculture and Research Institute, Karaikal, Union Territory of Puducherry was undertaken during kharif 2019 and rabi 2019- 2020. The aquatic coleopterans were collected in irrigated rice fields at weekly intervals from July 2019 to February 2020 in the eastern farm (10º95’N, 79º78’E and 4 masl). The study area received an average annual rainfall of 126 cm and irrigation water from Mettur dam of Tamil Nadu. The aquatic coleopterans were collected with a D- frame dip net which was measured about 12” wide x 10” tall (305 x 254 mm) and 22” depth made up of white nylon cloth with a 500 µm mesh. The handle of the dip net measured about 52” length and 32 mm in diameter. The collections were carried out in the early morning from 6.00 am to 9.00 am at weekly intervals from transplanting to before harvest. A total of 25 sweeps were made in five sites in the existing rice fields at random. It was passed through the standing water in the rice fields and then shaken in the standing water to remove silt and mud. The leftover contents of the net including the trapped aquatic insects were transferred to the white pan of 27.5x 35x 5.5 cm size with about 2 cm of water in it and from white pan the aquatic insects were sorted out after complete washing. Most of the surface swimming insects like whirligig beetles were collected by dragging a dip net on the water surface (half submerged) and then from dip net they were picked up by hand and put into vials containing 70% ethanol (Darilmaz and Ahmed, 2015; Wakhid et al., 2020).

The collected specimens after sorting out to family level were stored in 30 ml vials containing 70% ethanol with few drops of glycerine and preserved in insect storage boxes for identification up to species level (Walker et al., 1999). These were got identified by Dr K A Subramanian (Scientist-D) and Mrs Rita Deb (Sr Zoological Assistant), ZSI, Pune, Maharashtra using Vazirani (1970, 1984) and Biswas and Mukhopadyaya (1995). The voucher specimens were deposited in the Western Regional Centre, ZSI, Pune, Maharashtra. All images of identified aquatic insects were captured with Nikon D5300 DSLR camera and Leica EZ4E stereozoom microscope. The weekly weather data were obtained from the Agrometeorological observatory, Department of Agronomy, PAJANCOA and RI, Karaikal. The diversity indices namely Simpson index (λ), Shannon-Wiener (H^1), Pielou evenness index (E_1), Menhinick index, Margalef index, Equitability- J and Berger-Parker of dominance were analysed. Correlation and multiple regression analyses were carried out to evaluate the abundance of aquatic coleopterans in relation to physico-chemical characteristics. All analyses were done with Past version 4.0 (Hammer et al., 2001) and R software version 3.6.2 (Mendiburu, 2015).

RESULTS AND DISCUSSION

A total of 24 aquatic coleopteran species were observed in the irrigated rice ecosystem. During kharif 2019, a total of 593 individuals of aquatic coleopterans were collected which comprised 16 species under 12 genera and 3 families. Among the 16 species, *Berosus indicus, Hydroglyphus flammulatus* and *Regimbartia attenuata* were dominant with 108, 93 and 72 individuals, respectively. Among the three families, Dytiscidae was the most abundant (47.89%), followed by Hydrophilidae (42.67%) (Table 1). The reason for the abundance of Dytiscidae, might be due to its tolerance to thrive in saline conditions of the rice fields and survive in drying periods during kharif 2019. The present results are in line with those of Ponraman et al. (2016) on the aquatic coleopterans viz., *Hydrophilus* sp., *Berosus* sp., *Copelatus* sp., *Hydraticus* sp., *Dytiscus* sp., *Laccophilus* sp. and *Dineutus* sp. in Tamil Nadu during kuruvai season between June and October 2013. Ohba et al. (2013) reported 4 families of aquatic coleopterans viz., Hydrophilidae, Dytiscidae, Noteridae and Haliplidae collected between April and October 2009 in fallow rice fields of Western Japan. Rozilah and Ali (1998) observed Dytiscidae and Hydrophilidae in the Muda rice area of Malaysia.

A total of 1034 individuals of aquatic coleopterans were collected during rabi 2019- 2020 which comprised 18 species under 17 genera and 5 families. Among the 18 species, *B. indicus* was the dominant species with 311 individuals. Among the five families, the most abundant was Hydrophilidae (49.23%), followed by Dytiscidae (30.56%) (Table 1). The rabi rice crop received high rainfall and water from Mettur dam of Tamil Nadu which might be the reason for the abundance of the Hydrophilidae. The present findings corroborate with those of Jana et al. (2009) that the dominant families were Dytiscidae (85%) and Hydrophylidae (15%). Thakare and Zade (2011) reported that Dytiscidae was the dominant family (76.92%), followed by Hydrophilidae (15.38%) in Maharashtra. Similarly, Hydrophilidae (48%), Dytiscidae (27%) and Noteridae (18%) were recorded from rice growing area of North Eastern Argentina (Lutz et al., 2015).

This study revealed higher proportion of predators in the family Dytiscidae (Table 1). It also revealed that in both seasons, the diversity index values for dominance (D) was <1 and the maximum diversity indices of Simpson index (λ) (0.898), Shannon-Weiner (H^1) (2.485), Pielou evenness index (E_1) (0.75), Menhinick (0.657) and Equitability- J (0.896) were observed in kharif 2019. The maximum dominance based on Margalef index (2.449) and Berger Parker index (0.301) were observed rabi 2019 - 2020. The present findings are in contrast with the findings of Zhang et al. (2013), who reported that the evenness index in early season crop (April-July) was 0.63 and 0.71 in late season crop (August-November) in an organic rice ecosystem in China. Dytiscidae exhibited a significant negative correlation (-0.35) with the water temperature; while Gyrinidae, Hydrophilidae and Noteridae showed significant negative correlation with pH (-0.44, -0.35, -0.44), electrical conductivity (-0.57, -0.74, -0.64), air temperature (-0.53, -0.63, -0.56) and water temperature (-069, -0.60, -0.70), and positive significant correlation

Table. 1 Diversity and dominance of aquatic Coleoptera in irrigated rice ecosystem

S. No.	Taxa	kharif 2019		rabi 2019 - 2020		Total
		RA (%)	Status of dominance*	RA (%)	Status of dominance*	
I	Dytiscidae (Predaceous diving beetles)					
1.	*Copelatus* sp.	2.02	Recedent	-	-	12
2.	*Cybister fimbriolatus* Say	0.17	Subrecedent	-	-	1
3.	*C. tripunctatus* Olivier	-	-	0.68	Subrecedent	7
4.	*Eretes griseus* F.	5.40	Subdominant	2.51	Recedent	58
5.	*Hydaticus fabricii* Macleay	4.38	Subdominant	2.03	Recedent	47
6.	*Hydroglyphus flammulatus* Sharp	15.68	Dominant	6.19	Subdominant	157
7.	*H. signatellus* Klug (Fig.7)	-	-	8.51	Subdominant	88
8.	*Hydrovatus confertus* Sharp	-	-	3.48	Subdominant	36
9.	*Hyphydrus lyratus* Sharp	-	-	0.48	Subrecedent	5
10.	*Laccophilus anticatus* Sharp	6.07	Subdominant	-	-	36
11.	*L. inefficiens* Walker	5.56	Subdominant	-	-	33
12.	*L. sharpi* Regimbart	8.60	Subdominant	6.67	Subdominant	120
II	Gyrinidae (Whirligig beetle)					
1.	*Dineutus unidentatus* Aube	-	-	4.64	Subdominant	48
III	Haliplidae (Crawling water beetle)					
1.	*Peltodytes* sp.	-	-	0.1	Subrecedent	1
IV	Hydrophilidae (Water scavenger beetles)					
1.	*Berosus indicus* Motschulsky	18.21	Dominant	30.08	Dominant	419
2.	*B. pulchellus* MacLeay	4.38	Subdominant	6.48	Subdominant	93
3.	*Helochares pallens* MacLeay	-	-	0.19	Subrecedent	2
4.	*Hydrophilus indicus* Bedel	4.22	Subdominant	6.48	Subdominant	92
5.	*Regimbartia attenuata* F.	12.14	Dominant	6.01	Subdominant	134
6.	*Sternolophus rufipes* F.	2.53	Recedent	-	-	15
7.	*Tropisternus lateralis* F.	1.18	Recedent	-	-	7
V	Noteridae (Burrowing water beetles)					
1.	*Canthydrus angularis* Sharp	5.73	Subdominant	4.06	Subdominant	76
2.	*C. laetabilis* Walker	3.73	Subdominant	4.74	Subdominant	71
3.	*Neohydrocoptus subvittulus* Motschulsky	-	-	6.67	Subdominant	69

Diversity indices	kharif 2019	rabi 2019 - 2020
Species richness	16	18
Individuals	593	1034
Dominance- D	0.101	0.130
Simpson's diversity index (λ)	0.898	0.869
Shannon-Wiener's diversity index (H^1)	2.485	2.412
Menhinick's richness index	0.657	0.559
Margalef's richness index	2.349	2.449
Pielou's evenness index (E_1)	0.750	0.620
Equitability- J of evenness	0.896	0.834
Berger-Parker dominance index	0.182	0.301

* As per Engelmann scale (Engelmann, 1978) - Relative abundance % (RA) <1- Subrecedent; 1.1–3.1 -Recedent; 3.2–10 - Subdominant; 10.1–31.6 - Dominant and > 31.7 Eudominant

Table 2. Population dynamics of aquatic Coleoptera in rice ecosystem

Family	pH	EC	AT	WT	RH	RF	Regression equation	R^2
Dytiscidae	-0.03	-0.33	-0.10	-0.35*	0.06	-0.12	$Y= 26.96 +5.97X_1 -6.85X_2 +2.41X_3 -4.45X_4 -0.20X_5 +0.01X_6$	0.923*
Gyrinidae	-0.44*	-0.57*	-0.53*	-0.69*	0.41*	0.05	$Y= 39.29 -0.05X_1 -0.67X_2 -0.05X_3 -1.03X_4 -0.11X_5$	0.516*
Haliplidae	-0.08	-0.20	-0.21	-0.08	0.10	0.30	$Y= 1.22 -0.05X_2 -0.03X_3 +0.02X_4 -0.01X_5$	0.134#
Hydrophilidae	-0.35*	-0.74*	-0.68*	-0.60*	0.54*	0.27	$Y= 103.95 +0.31X_1 -14.52X_2 -2.39X_3 +1.29X_4 -0.19X_5 -0.02X_6$	0.606*
Noteridae	-0.44*	-0.64*	-0.56*	-0.70*	0.39*	0.05	$Y= 105.95 +0.11X_1 -2.79X_2 -0.52X_3 -1.93X_4 -0.37X_5$	0.596*

* - Significant at p<0.05; # - Not significant; X_1- water pH; X_2- Electrical conductivity (EC); X_3- Air temperature (AT); X_4- Water temperature (WT); X_5- Relative humidity (RH); X_6- Rainfall (RF)

with relative humidity (0.41, 0.54, 0.39). Multiple linear regression also indicated that all the physico-chemical characteristics together were responsible for significant variation on the occurrence of Dytiscidae (92%), Gyrinidae (51%), Hydrophilidae (60%) and Noteridae (59%) (Table. 2). Though the diversity was severely affected by the regular agronomic practices, these rice fields act as temporary wetlands substitute to the natural wetlands which provides habitat for the conservation of the different species of aquatic coleopteran including other macro-invertebrates.

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