

MORPHOLOGICAL DIFFERENCES IN THREE SPECIES OF THE GENUS *DIPLONYCHUS* (HEMIPTERA : BELOSTOMATIDAE) KNOWN FROM INDIA

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INTRODUCTION

Belostomatidae commonly called as giant water bug belongs to the infraorder Nepomorpha. Thirumalai (2007) recorded three species of the genus *Diplonychus* from India. These predatory insects feed on aquatic crustaceans, fishes, amphibians and mosquito larvae. The results of Saha (2007) reveal that a single adult of *D. rusticus* could consume 11-87 fourth instar larvae of *Culex quinquefasciatus* Say per day and *D. annulatus* consume 33-122 fourth instar larvae per day, depending upon the prey and predator densities. These insects are used as bioindicators of water quality and biocontrol method. Corbi *et al.* (2010) analysed the Ion concentration of Al, Cd, Cr, Cu, Zn, Fe and Mn in adult Belostomatidae. For undertaking any kind of applied research, the correct species identification is important. Since the species *Diplonychus molestus* resembles *Diplonychus rusticus*, which pose to doubt in the determination of species, therefore the present study was undertaken to provide clear cut identification of all the species of the genus known from India.

MATERIALS AND METHODS

Differences in some important morphological characteristics of three species of genus *Diplonychus* belongs to the infraorder Nepomorpha and family Belostomatidae, were studied from the reference collections of Zoological Survey of India, Jabalpur. The specimens were collected by using D- frame aquatic net and preserved in 75 % alcohol. Some of the specimens were pinned. The specimens were identified and measurements were taken by using Leica Stereozoom microscope (Leica M205 A) and

the photographs were taken by using Leica Microscope (Leica MZ 125) and Leica Stereozoom microscope (Leica M205 A). In case of *D. rusticus* only the flightless morphs are considered for taking measurements and for mentioning the characters in the Table 2, since more number of flightless morph were examined in the present study.

Key to the species of *Diplonychus* of India

1. Hemelytra with spiny patch on corium, fore tarsus 1 jointed, small species2
- Hemelytra without spiny patch on corium, fore tarsus 2 jointed, apex of head acute, respiratory straps without cluster of setae, large species..... *D. annulatus*
2. Respiratory straps without cluster of setae, posterior pronotal angles more obtuse *D. molestus*
- Respiratory straps with cluster of setae, posterior pronotal angles less acute *D. rusticus*

Diplonychus annulatus (Fabricius, 1781)

1781. *Nepa annulata* Fabricius, *Carol. Ernest. Bokhni. Hamburgi et Kiloni*, 333.

2002. *Diplonychus annulatus* (Fabricius): Thirumalai, Metha & Sharma, *Res. Bull. Panjab Univ.*, 52: 157.

Material examined : **Bastar**, Jagadapur, 12.i.1974, (2 ♀, 1 ♂ exs.), Coll. R.K. Singh & Party., **Bilaspur**, Khutaghat, 7.iii.1992, (3 ♀ exs.), Korba, 8.iii.1992, (2 ♂, 1 ♀ exs.), Coll. U.A. Gajbe & Party; **Jabalpur**, Amkhas, 25.vi.1970, (1 ♂ ex.); Mohania Village, 27.X.1975, (2 ♂ exs.); Nansat Village, 24.iii.1964, (1 ♀ ex.); Surajla tank, Nagpur Road, 24.vii.1970, (1 ♀ ex.); Urana tank, Patan Village, 23.iv.1964, (1 ♀ ex.),

Coll. H.P. Agrawal; Banala, 2.i.1961, (1 ♂ ex.), Coll. S. Chakarapany; Garha Village, 20.HU965, (1 ♀ ex.), Coll. MX. Khosta; Barela tank, 29.v.1974, (1♂, 2 ♀ exs.), Coll. D.S. Mathur & Party; Panagar tank on Katni Road, 28.ii.1974, (1 ♂ ex.), Coll. R.K. Singh; **Morena**, Noorabad, 6.i.1995, (1 ♂ ex.); **Raipur**, Khosi Nala, 5.xii.1991, (2 ♀ exs.), Coll. H.S. Sharma; **Rewa**, Lakhori Bagh, 17.x. 1986, (1 ♀ ex.), Coll. D.S. Mathur & Party; **Sarguja**, Ambikapur, 9.i.1975, (1 ♂ ex.), Coll. H. Khajuria & Party; **Shivpuri**, SSS Club, 24.iii.1980, (1 ♂ ex.), Coll. D.K. Harshey.

Distribution : Andhra Pradesh, Assam, Bihar, Chandigarh, Chhattisgarh, Delhi, Gujarat, Kerala, Madhya Pradesh, Maharashtra, Odisha, Punjab, Rajasthan, Tamil Nadu, Uttar Pradesh and West Bengal. *Elsewhere*: Bangladesh and Pakistan.

***Diptonychus molestus* (Dufour, 1863)**

1863. *Appasus molestum* Dufour, *Ann. Soc. Ent. France*, 4(3): 395.

2004. *Diplonychus molestus* (Dufour): Bal & Basu, *Zool. Surv. India, State Fauna Series*, 10: 302.

Material examined : **Bharauch**, PWD Rest House, 19.i.1980, (5 ♂, 5 ♀ exs.) Coll. U.A. Gajbe; **Bhopal**, Bhopal Lake, 23.iii.1979, (1 ♀ ex.), Coll. P.D. Rane; **Bilaspur**, Korba, 8.iii.1992, (1 ♂, 3 ♀ exs.); Chhattisgarh, Shanti Nagar, **Rajnandgaon**, 22.xii.1983, (1 ♂ ex.) Coll. U.A. Gajbe; **Damoh**, VDWLS, 18.xi.2009, (1♂, 2 ♀ exs.); Kodi Kalam, 23.vi.2010, (2 ♂, 5 ♀ exs.), Sangrampur, 24.vi.2010, (2 ♂, 4 ♀ exs.); Kola Nala, 25.vi.2010, (1 ♂, 3 ♀ exs.), Coll. J. Thilak; Bhaisaghat, 22.vii.2009, (1 ♂, 1 ♀ exs.), Coll. K. Chandra; **Hoshangabad**, Bandsobhan Village, 13.i.1990, (1 ♀ ex.); Narmada Railway Road Bridge, 9.i.1990, (4 ♂, 2 ♀ exs.); Tewa River Bridge, 12.i.1990, (3 ♂, 6 ♀ exs.), Coll. U.A. Gajbe; Narmada river, 29.iii.1979, (1 ♀ ex.) Coll. P.D. Rane & Party; **Jabalpur**, Amkhas, 19.viii.1966, (1 ♂ ex.), Bhedaghat, 19.vii.1965, (2 ♀ exs.), Coll. H.P. Agrawal; Budhagar tank, 22.xii.1975, (1 ♀ ex.), Coll. D.S. Mathur & Party; Garha Village, 20.iii.1965, (1 ♂ ex.), Coll. M.L. Koshta; Heron River, Katangi Road, 10.vi.1969, (7♂, 3 ♀ exs.), Coll. V.V. Rao; Indrana Village, 9.xii.1980, (1 ♂, ♀ exs.) Coll. H.S. Sharma; Lamataghat, 3.v.1975, (1 ♂ ex.) Coll. H. Khajuria; 6.i.1967, (1 ♂, 5 ♀ exs.) Coll. H.S. Sharma & Party; 3.iv.1968, (1 ♂ ex.), Coll. H.P. Agrawal; 11.x.1967, (1 ♀ ex.) Coll. V.S. Durve; 31.x.1969, (1 ♂, 2 ♀ exs.),

Coll. V.V. Rao; Medical College Area, Nagpur Road, 13.ix.1966, (6 ♂, 1 ♀ exs.), Coll. H.P. Agrawal & Party; Murrari Katangi Road, 28.x.2003, (1 ♀ ex.), Coll. M.L. Dhimeh; Pariat River on Katni Road, 11.xi.1965, (2 ♀ exs.), Coll. H.P. Agrawal; 5.X.1966, (1 ♀ ex.), Coll. V.S. Durve; 11.x. 1968, (1 ♂ ex.), Coll. V.S. Durve; Patan Village, 26.vii.1966, (2 ♂, 1 ♀ exs.), Coll. H.P. Agrawal; Sardar bazaar, 17.ii.1966, (3 ♂, 4 ♀ exs.), Coll. M.L. Koshta; 23.iii.1966, (1 ♀ ex.), Sasan Village, 20.vii.1968, (1 ♀ ex.) Coll. H. Khajuria; Shapura Road, 31.xii.1975, (1 ♂, 2 ♀ exs.), Coll. P.D. Rane; Sukha Village, 30.vii.1965, (1 ♂, 5 ♀ exs.), Coll. H.P. Agrawal; CZRC, ZSI Res. Colony, 29.vii.2010, (6 ♂, 1 ♀ exs.), Coll. Devanshu; 27.ix.2010, (1 ♂ ex.), 30.ix.2010, (23 ♂, 20 ♀ exs.), 26.vi.2011, (1 ♂ ex.), Coll. E. E. Jehamalar. Khandwa, Om Kare Road, 28.ix.2007, (1 ♀ ex.), Coll. D.K. Harshey; **Khargone**, Badwah, 8.x.2007 (2 ♂, 3 ♀ exs.), Coll. D.K. Harshey; **Mirzapur**, Kaimur WLS, 30.vii.1999, (1 ♀ ex.) Coll. K. Chandra; Morena, Kunwari River, 13.x.1995, (1 ♂ ex.), Noorabad, 6.x.1995, (1 ♀, ex.), Pilua Dam, 8.i.1995, (5 ♀ ex.), Coll. H.S. Sharma; **Narsinghpur**, Barman Kala Village, 17.xii.1964, (3 ♀ ex.), Coll. H. Khajuria; **Panna**, Beni sagar, 17.xi.1988, (1 ♀ ex.), Coll. H.P. Agrawal; **Raipur**, Baloda Bazar, 7.xii.1991, (2 ♂ ex.), Coll. H.S. Sharma & Party; **Raisen**, Reechaa River, 2.x. 1995, (1 ♀ ex.), Coll. H.S. Sharma & Y.N. Gupta; Singhori WLS, Peepalvali, 17.ii.2010, (1 ♀ ex.), Coll. J. Thilak; **Rajgarh**, Newas River, 8.x.1995, (1 ♀ ex.), Coll. Y.N. Gupta & H.S. Sharma; **Rewa**, Beehar-Bichia river, Ghaghar area, 15.x.1986, (1 ♀ ex.), Coll. D.S. Mathur & Party; **Sagar**, Ratona village, 16.iii.1979, (3 ♂, 2 ♀ exs.), Coll. P.D. Rane; **Seoni**, Karmajhiri, 24.vi.2001, (1 ♀ ex.), Coll. K. Chandra; **Shivpuri**, Madav Lake, 29.iii.1980, (1 ♂ ex.), Coll. D.K. Harshey; SSS Club, 29.ix.1975, (3 ♀, 1 ♂ exs.), 21.ix.1975, (29 ♀ exs.), 23.ix.1975, (1 ♀ ex.), 24.ix.1975, (1 ♀ ex.), Coll. R.K. Singh; 24.iii.1980, (1 ♀ ex.), Coll. D.K. Harshey; **Sidhi**, Mohania, 24.vii.1999, (1 ♀ ex.), 25.vii.1999, (1 ♀ ex.), Coll. K. Chandra; **Ujjain**, Jaisinghpura, 25.ii.1981, (1 ♀ ex.), Coll. H.P. Agrawal; Hama Depo, 4.x.1993, (1 ♀ ex.), Coll. R.K. Singh.

Distribution : Andhra Pradesh, Bihar, Chandigarh, Chhattisgarh, Delhi, Himachal Pradesh, Jammu & Kashmir, Kerala, Madhya Pradesh, Maharashtra, Manipur, Odisha, Punjab, Tripura, Uttar Pradesh and West Bengal.

***Diplonychus rusticus* (Fabricius, 1781)**

1781. *Nepa rustica* Fabricius, *Species insectorum*, 2: 333.

2005. *Diplonychus rusticus* (Fabricius): Thirumalai & Sureshkumar, *Rec. zool. Surv:India*, 105: 13.

Material examined : **Bilaspur**, Korba, 8.iii.1992, (1 ♂, 4 ♀ exs.), Coll. U.A. Gajbe; Nawer Talab, Ratanpur, 20.ii.1979, (8 ♂, 8 ♀ exs.), Coll. K. Reddiah; **Damoh**, Hatta, 18.i.1994, (4 ♂, 3 ♀ exs.), 17.i.1994, (3 ♂, 4 ♀ exs.). Coll. H.P. Agrawal; **Hoshangabad**, Narmada River, 25.xii.1964, (1 ♂, 3 ♀ exs.), 14.iii.1980, (3 ♂, 5 ♀ exs.), Coll. H. Khajuria & Party; Joga, 17.xii.1965, (1 ♂ ex.), Kacherighat, Coll. H.P. Agrawal & Party; **Jabalpur**, Amkhas, 16.iv.1966, (2 ♂, 3 ♀ exs.); 19.viii.1966, (1 ♀ ex.), 19.x.1968, (1 ♀ ex.), Coll. H.P. Agrawal; 19.iv.1975, (1 ♀ ex.), 15.i.1976, (2 ♀ exs.), Coll. B.S. Guram & Party; 10.viii.1966, (1 ♀ ex.), Coll. V.V. Rao & Party; Amkhash, 6.v.1975, (1 ♂, 1 ♀ exs.), Coll. P.D. Rane & Party; Amkhas, 4.ix.1970, (2 ♂ exs.), Coll. H.S. Sharma; Baleha tank, Panagar Village, 20.ii.1968, (1 ♂ ex.), 8.1.1969, (6 ♂, 3 ♀ exs.), 30.xii.1969, (4 ♂, 1 ♀ exs.), 12.vi.1970, (6 ♂, 9 ♀ exs.), Coll. H.P. Agrawal; 7.ii.1968, (4 ♀ exs.), Coll. V.V. Rao & Party; Bargi Village, 5.ix.1969, (1 ♂ ex.), Coll. H.P. Agrawal; Basan Village, 13.iv.1983, (2 ♀ ex.), Coll. U.A. Gajbe; Bheraghat, Nagpur Road, 7.iii.1970, (2 ♀ exs.), 19.vii.1965, (1 ♀ ex.), Coll. H.P. Agrawal; Bhiloda village, 24.vii.1965, (1 ♀ ex.), Coll. D.N. Basu & Party; Boria Village, 14.ix.1965, (1 ♀ ex.), Budagar tank, Katni Road, 25.ii.1969, (2 ♂, 2 ♀ exs.), 15.vii.1970, (13 ♂, 10 ♀ exs.), Coll. H.P. Agrawal; 20.iii.1974, (9 ♂, 4 ♀ exs.), 22.xii.1975, (9 ♂, 13 ♀ exs.), 23.i.1976, (19 ♂, 12 ♀ exs.), Coll. D.S. Mathur & Party; 19.vii.1969, (1 ♀ ex.), 14.iv.1970, (1 ♀ ex.), Coll. V.V. Rao & Party; 26.x.1976, (1 ♂, 1 ♀ exs.), Coll. K. Reddiah; 30.vii.1969, (1 ♂, 1 ♀ exs.), 29.x.1971, (1 ♂, 2 ♀ exs.), Coll. H.S. Sharma & Party; Dertal tank, Garha, 20.iv.1966, (2 ♂, 4 ♀ exs.), Coll. M.L. Koshta & Party; Gandhigram, Katni Road, 8.x.1968, (1 ♂ ex.), Coll. H.P. Agrawal & Party; 5.x.1966, (1 ♀ ex.), Coll. V.S. Durve; Garha Village, 26.ii.1962, (16 ♂, 23 ♀ exs.), Coll. P. Singh; 20.iii.1965, (2 ♂, 3 ♀ exs.), Coll. M.L. Koshta; Ganga Sagar tank, 26.ii.1963, (1 ♀ ex.), Coll. P. Singh; Heron River, Ganiari village, 12.v.1966, (2 ♂ 9 ♀ exs.), Katangi

village, 16.vi.1966, (6 ♂, 7 ♀ exs.), Coll. H.S. Sharma & Party; Heron River on Katni Road, 5.x.1966, (1 ♂ ex.), Coll. V.S. Durve; Kiti village, 26.xii.1965, (2 ♀ exs.), Coll. H.P. Agrawal & Party; Madan Mahal, 3.v.1966, (1 ♀ ex.), Coll. H.P. Agrawal; 17.ii.1967, (1 ♂ ex.), Coll. H. Khajuria & Party; 4.iv.1975, (1 ♀ ex.), Coll. S.K. Mishra & Party; Medical College Area, Nagpur road, 13.ix.1966, (1 ♂ ex.), Coll. H.P. Agrawal & Party; Panagar Village, 29.vi.1968, (2 ♂, 2 ♀ exs.), Coll. H.P. Agrawal & Party; Parlat River, 5.xii.1969, (6 ♀ exs.), Coll. V.V. Rao & Party; Ranital, 15.vii.1969, (1 ♂ ex.), Coll. V.V. Rao; Richhai Village, 29.iv.1964, (1 ♂ ex.), 20.iv.1965, (10 ♂, 13 ♀ exs.), Coll. H.P. Agrawal; 9.ii.1966, (5 ♂, 3 ♀ exs.), Coll. V.V. Rao & Party; Sasan Village, Patan Road, 20.vii.1968, (1 ♂, 1 ♀ exs.), Coll. H. Khajuria; Shapura Road, 31.xii.1975, (3 ♂, 3 ♀ exs.), Coll. P.D. Rane; Supatal, 6.vi.1968, (1 ♂ ex.); Surajla tank, Nagpur Road, 20.ii.1968, (1 ♀ ex.), 12.ii.1970, (1 ♂, 3 ♀ exs.), 24.vii.1970, (4 ♂, 2 ♀ exs.); Supatal on Nagpur Road, 6.vi.1968, (1 ♀ ex.); Tewal Village, 16.v.1964, (2 ♀ exs.); Tilwaraghat, 16.iv.1969, (2 ♀ exs.), Coll. H.P. Agrawal & Party; ZSI Res. Colony, Ekta Chowk, 27.ix.2010, (1 ♂ ex.), Coll. E.E. Jehamalar; **Mandsaur**, Near Gandhi Sagar, 17.viii.1990, (1 ♀ ex.), Coll. R.K. Singh & Party; **Narsinghpur**, Burman Village, (6 ♂ exs.), 18.xii.1964, Coll. H. Khajuria & Party; Panna, A nala on Panna, 20.xi.1988, (1 ♀ ex.), Coll. H.P. Agrawal; Sagar, A tank on Sagar, 17.iii.1979, (1 ♀ ex.), Coll. R.D. Rane & Party; **Sarguja**, Ambikapur, 9.i.1975, (6 ♂, 9 ♀ exs.), Coll. H. Khajuria & Party; **Shivpuri**, A nala on Bhadaya Kund Road, 26.iii.1980, (1 ♀ ex.), Coll. D.K. Harshey.

Distribution : Andaman & Nicobar Islands, Andhra Pradesh, Arunachal Pradesh, Assam, Bihar, Chandigarh, Chhattisgarh, Delhi, Goa, Gujarat, Himachal Pradesh, Jammu & Kashmir, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Manipur, Meghalaya, Odisha, Puducherry, Punjab, Rajasthan, Tamil Nadu, Tripura, Uttar Pradesh and West Bengal. *Elsewhere* : Australia, Austria, China, Formosa, Indonesia, Japan, Java, Malay Peninsula, Myanmar, New Zealand, Philippines, Sri Lanka, Thailand and New Guinea.

Table 1. LENGTH AND WIDTH OF SOME MORPHOLOGICAL CHARACTERS OF THREE SPECIES OF *DIPLONYCHUS*

Characters	Measurements (mm)	<i>Diplonychus annulatus</i>	<i>Diplonychus molestus</i>	<i>Diplonychus rusticus</i>
Number of specimens examined		27 (12 ♂, 15 ♀)	206 (90 ♂, 116 ♀)	383 (176 ♂, 207 ♀)
Body	Length	20.59 - 22.01	15.52 - 17.23	15.56 - 16.46
	Width	13.75 - 14.21	9.74 - 10.04	9.92 - 10.12
Head	Length	2.10 - 2.63	1.22 - 1.45	1.23 - 1.44
	Width	5.46 - 5.52	4.26 - 4.47	3.97 - 4.28
Spiny wing patch	Length	absent	0.37 - 0.41	0.81 - 0.97
	Width		0.43 - 0.46	0.42 - 0.45
Hemelytra	Length	15.57 - 16.02	12.84 - 13.16	11.91 - 12.39
	Width	6.88 - 7.21	4.83 - 5.67	4.72 - 5.45
Wing membrane	Length	1.54 - 1.73	1.98 - 2.18	0.86 - 1.29
	Width	1.53 - 2.08	3.02 - 3.74	1.52 - 2.01

Table 2. COMPARISON OF THE MORPHOLOGICAL CHARACTERS OF THREE SPECIES OF *DIPLONYCHUS*

Characters	<i>Diplonychus annulatus</i>	<i>Diplonychus molestus</i>	<i>Diplonychus rusticus</i>
Apex of head	Acute (Fig. 1)	Blunt (Fig. 2)	Blunt (Fig. 3)
Posterior pronotal angle	Acute, with setae (Fig. 4)	More obtuse, without setae (Fig. 5)	Less acute, without setae (Fig. 6)
Anterior tarsus	Two segmented (Fig. 7)	One segmented (Fig. 8)	One segmented (Fig. 9)
Hemelytra	Broad	Longer than broad	Longer than broad
Wing membrane	Small and not extended to inner margin	Large and extended to inner margin	Small and extended to inner margin
Spiny patch of corium	Absent	Almost round	Oblong
Inner subapex of corium	Straight	Inwardly curved	Almost straight
Male genital plate	More acute	Less acute	More obtuse
Hind wing	Linear (Fig. 10)	Linear (Fig. 11)	Broad (Fig. 12)
Pubscent stripe of abdominal sternum	More distinct (Fig. 13)	Obscure (Fig. 14)	More distinct (Fig. 15)
Males with tuft of setae on respiratory strap	Absent (Fig. 16)	Absent (Fig. 17)	Present (Fig. 18)
Male paramere	Almost straight (Fig. 22)	Almost straight (Fig. 23)	Curved (Fig. 24)

SUMMARY

The measurement values of three species of *Diplonychus* were presented in the Table-1. *D. annulatus* is the largest species having the maximum length and width of whole body, head and the wing, when compared to *D. molestus* and *D. rusticus*. In *D. molestus* the membrane of hemelytra and the hind wing is well developed and can be easily diagnose from other two. Inner subapex of corium is inwardly curved in *D. molestus* and flight morph of *D. rusticus* but which is straight in *D. annulatus* and flightless morph of *D. rusticus*. Pubescent stripe on the lateral abdominal sternum having much variation among three species. The pubescent stripe is distinctly sinuate along the inner margin in *D. annulatus*, it is less sinuate and the stripe not so prominent in *D. molestus* when compared to *D. annulatus* and *D. rusticus*. The pubescent stripe is lean, very prominent and sinuate in the inner margin in *D. rusticus*. In *D. molestus* the outer bare stripe is less in width than the pubescent stripe.

Few aforesaid characters are not uniform in all the individuals of the same population, the postero pronotal angle, the hemelytra and the hind wing varies remarkably in *D. rusticus*. The flightless morph can easily be distinguished from *D. molestus* by their acute postero pronotal angle, poorly developed hemelytral membrane and strap-like hindwing. But the flight morph (which attracted towards light) very closely resemble to the *D. molestus* except by their tuft of hairs on the respiratory strap in males, male paramere and the pubescent stripe on the abdominal sternum. Lee (1991) found different wing morphs in a single population of *D. rusticus*. Little differences also noticed in the same population of *D. molestus* in the postero pronotal angle and the hemelytral membrane. The structure of postero pronotal angle not differs much but sometimes it overlaps the base of hemelytra and sometimes it is not overlaps. The hemelytral membrane is also with slight difference in the flight and flightless morphs. Lip mark character on the sub apex of scutellum of *D. rusticus* which was used by Lee (1991) is not

prominent in all the individuals of the same species but sometimes visible in wet condition and once get dried the lip mark is not prominent. Venkatesan and Rao (1980) mentioned that segment 1 of the tarsus shorter than segment II and the division being visible on the ventral side. This character is also not prominent in the specimens examined in the present study. So in the present study these characters are not considered. Male female differences of these three species of *Diplonychus* were also provided in the photograph, which helps the scientific community to perform various studies. The male subgenital plate is little longer and acute than the females of all the three species. Slight variation in the genital structure of *D. rusticus* and *D. molestus* were noticed in the present study. The size of *D. rusticus* also varied from region to region.

Venkatesan and Rao (1980) mentioned that *D. rusticus* male without setal tufts on the respiratory strap. It is a wrong concept, all the male specimens of *D. rusticus* we examined are having setal tufts on respiratory strap. After studying the specimens of *D. indicus* Venkatesan and Rao, 1980, Polhemus (1995) found that the *D. indicus* and *D. rusticus* are the same species, there are no differences between them and he concluded that *D. indicus* must fall as a junior synonym of *D. rusticus*. The naming of *D. indicus* by Venkatesan and Rao (1980) four species were previously known from India. Many workers consider *D. indicus* as a separate species and used in their scientific studies. The present study clearly mentioned the variation among the three species from the genus *Diplonychus* so far known from India. Polhemus (1995) pointed out that *Diplonychus annulatus* (Fabricius) has a much more restricted distribution than *D. rusticus* (Fabricius). Later one is widely distributed in India than *D. annulatus* and *D. molestus*.

ACKNOWLEDGEMENTS

The authors are thankful to the Director, Dr. K. Venkataraman, Zoological Survey of India, Kolkata for the facilities and encouragements.

REFERENCES

- Corbi, J.J., Froehlich, C.G., Trivinho-Strixino, S. and dos Santos, A. 2010. Evaluating the use of predatory insects as bioindicators of metal contamination due to sugarcane cultivation in neotropical streams. *Environ. Monit. Assess.*, 1-10.

- Dufour, L. 1863. Essai monographique sur les Belostomatids. *Ann. Soc. Ent. France*, **4**(3): 373-400.
- Fabricius, J.C. 1781. Species insectorum exhibentes eorum differentias specificas, synonyma auctorum, locanatalia, metamorphosin adjectis observationibus, descriptionibus, Carol. Ernst. Bohnii, Hamburgi et Kiloni. 2 Vols; Vol. 1, viii+ 552 pp: Vol. 2, 494 pp + Appendix pp. 495-514 = Index pp. 515-517.
- Lee, C.E. 1991. Morphological and phylogenetic studies on the true water bugs (Hemiptera: Heteroptera). *Nature and Life*, **21**: 1-183.
- Polhemus, J.T. 1995. Nomenclature and synonymical notes on the genera *Diplonychus* Laporte and *Appasus* Amyot and Serville (Heteroptera: Belostomatidae). *Proc. Entomol. Soc. Wash*, **97**(3): 649-653.
- Saha, N., Aditya, G., Bal, A. and Saha, G.K.. 2007. A comparative study of predation of three aquatic heteropteran bugs on *Culex quinquefasciatus* larvae. *Limnology*, **8**(1): 73-80.
- Thirumalai, G. 2007. A synoptic list of Nepomorpha (Hemiptera: Heteroptera) from India. *Rec. zool. Surv. India. Occ. Paper No.*, **273**: 1-84.
- Venkatesan, P. and Rao, T. K. R. 1980. Description of a new species and a key to Indian species of Belostomatidae. *Journal of the Bombay Natural History Society*, **77**: 299-303.

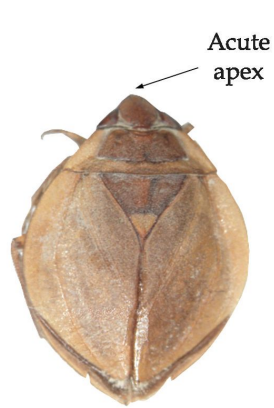


Fig. 1. *Diplonychus annulatus*



Fig. 2. *Diplonychus molestus*



Fig. 3. *Diplonychus rusticus*

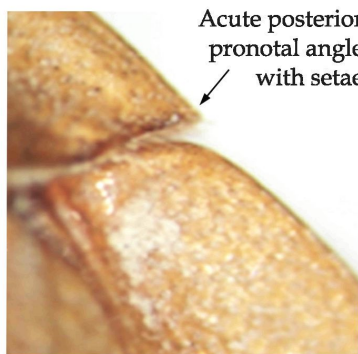


Fig. 4. Part of pronotum and abdomen of *D. annulatus* showing posterior pronotal angle

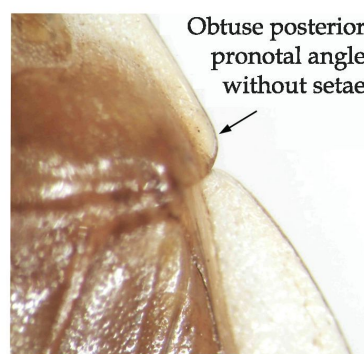


Fig. 5. Part of pronotum and abdomen of *D. molestus* showing posterior pronotal angle

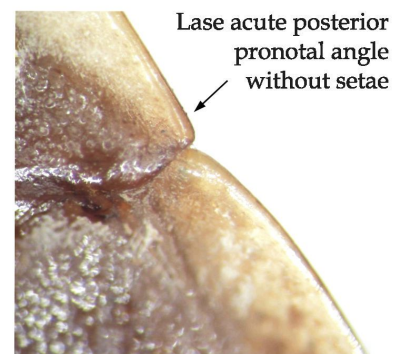


Fig. 6. Part of pronotum and abdomen of *D. rusticus* showing posterior pronotal angle

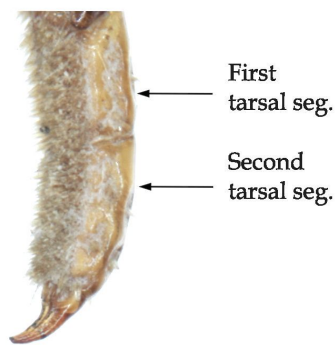


Fig. 7. Fore tarsus of *Diplonychus annulatus*



Fig. 8. Fore tarsus of *Diplonychus molestus*

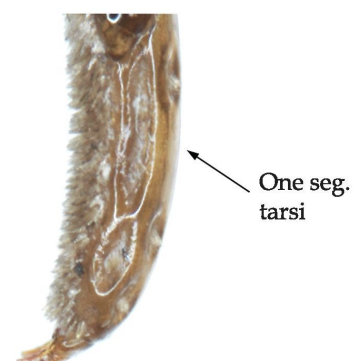


Fig. 9. Fore tarsus of *Diplonychus rusticus*



Fig. 10. Hind wing of *D. annulatus*



Fig. 11. Hind wing of *D. molestus*



Fig. 12. Hind wing of *D. rustictus*

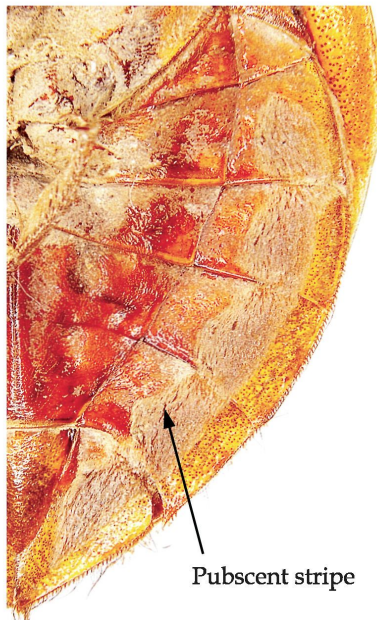


Fig. 13. Part of abdominal sternum of *D. annulatus* showing pubescent stripe



Fig. 14. Part of abdominal sternum of *D. molestus* showing pubescent stripe



Fig. 15. Part of abdominal sternum of *D. rustictus* showing pubescent stripe



Fig. 16. Genitalia and respiratory straps of male *Diplonychus annlatus*



Fig. 17. Genitalia and respiratory straps of male *Diplonychus molestus*

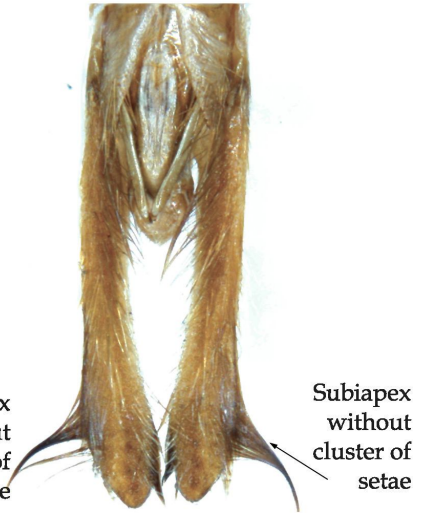


Fig. 18. Genitalia and respiratory straps of male *Diplonychus rusticus*



Fig. 19. Genitalia and respiratory straps of female *D. annlatus*

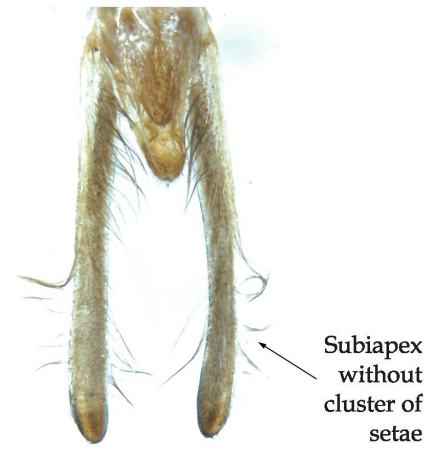


Fig. 20. Genitalia and respiratory straps of female *D. molestus*



Fig. 21. Genitalia and respiratory straps of female *D. rusticus*

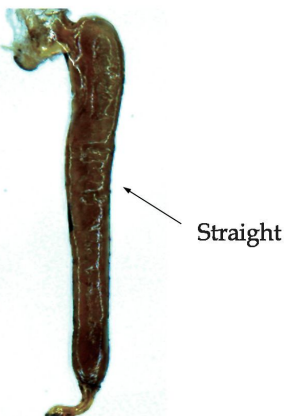


Fig. 22. Left paramere of *Diplonychus annlatus*

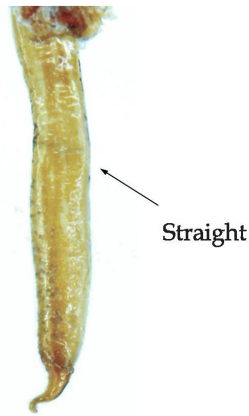


Fig. 23. Left paramere of *Diplonychus molestus*

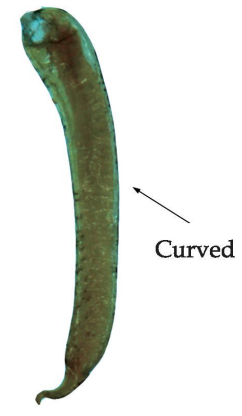


Fig. 24. Left paramere of *Diplonychus rusticus*