TÜBİTAK

Turkish Journal of Zoology

http://journals.tubitak.gov.tr/zoology/

Research Article

Turk J Zool
(2016) 40: 499-512
© TÜBİTAK
doi:10.3906/zoo-1505-44

A comparative description of the thorax chaetotaxy of the Dolichopodidae (Diptera)

Mariya Alexandrovna CHURSINA*, Oleg Pavlovich NEGROBOV, Olga Vladimirovna SELIVANOVA
Department of Ecology and Taxonomy of Invertebrates, Faculty of Biology, Voronezh State University, Voronezh, Russia

Received: 28.05.2015 • **Accepted/Published Online:** 25.02.2016 • **Final Version:** 09.06.2016

Abstract: A study of 270 species belonging to 210 genera of the family Dolichopodidae was conducted to examine their characters of thorax chaetotaxy. The quantity of acrostichal setae series, number of dorsocentral setae pairs, and quantity and degree of developed scutellar setae were studied. The humeral, posthumeral, intraalar, notopleural, supraalar, postalar, and sutural setae were also investigated. Combinations of chaetotaxy characters typical of the family Dolichopodidae were discovered. A detailed analysis of these characters allowed for the determination of the diagnostic characters of the subfamilies. The comparative analysis of Dolichopodidae morphology and outgroup taxa allowed for the identification of apomorphic and plesiomorphic character states of thorax chaetotaxy.

Key words: Diptera, Dolichopodidae, morphology, chaetotaxy, thorax, subfamily

1. Introduction

The number and arrangement of setae on the mesonotum are used in generic diagnosis and identification of the family Dolichopodidae. Moreover, the patterns of setae arrangement in flies have a long evolutionary path and should be used to study the phylogeny of the subfamilies and genera (Simpson et al., 1999).

Some chaetotaxy character states are common to all members of the family. Most often, there are one humeral, two supraalar, one postalar, and two notopleural setae (Figure 1). Typically, there are also one or two posthumeral and one presuturar intraalar setae. Reduction of the presutular or sutural setae was observed in some species.

Dipterous representatives from the family Dolichopodidae have from three to seven (or more) pairs of dorsocentral setae. It is often observed that two pairs are presutular and four pairs are postsutular; however, sometimes one, two, or three anterior pairs are absent, and the fifth pair is moved to the middle of the mesonotum or is absent. Acrostichal setae are usually much shorter than dorsocentral setae and, in some cases, are hardly visible; in fact, they are shorter than the interval between them, and acrostichal setae are either arranged in one or two series or are completely absent.

The number of scutellar setae and the presence of setae or hairs on the anaproepisternum (upper part of propleuron) and the kataproepisternum (lower part of propleuron) are both important diagnostic characters (Marina and Negrobov, 1977, 1980). Representatives of the family Dolichopodidae usually have one well-developed pair of medial (internal) scutellar setae and one pair of smaller lateral (outer) scutellar setae. However, two lateral setae can be absent or can be as long as medial setae. The anaproepisternum can have hairs or setae on the top of the base of the fore coxa. Sometimes there are one or more setae on the kataproepisternum (Figure 2).

Several character states of thorax chaetotaxy can vary within genera, such as the number of hairs on the humeral tubercle. Other character states are stable among the representatives of many genera, while varying among the representatives of other genera (Negrobov, 1979).

2. Materials and methods

A study of 270 species belonging to 210 genera of the Dolichopodidae family was conducted to examine the characters of thorax chaetotaxy (Table). The outgroup for this study consisted of six species broadly belonging to six genera of the family Dolichopodidae, the subfamilies Microphorinae and Parathalassinae, and four species of the family Empididae.

The following characters were studied: presence and arrangement of acrostichal setae; number of pairs of dorsocentral setae; number of presutular intraalar, supraalar, notopleural, and postalar setae; presence of sutural, humeral, and posthumeral setae; and number and degree of scutellar setae.

The data obtained were statistically analyzed. Data on the number and presence of dorsocentral, acrostichal, and

* Correspondence: chursina.1988@list.ru

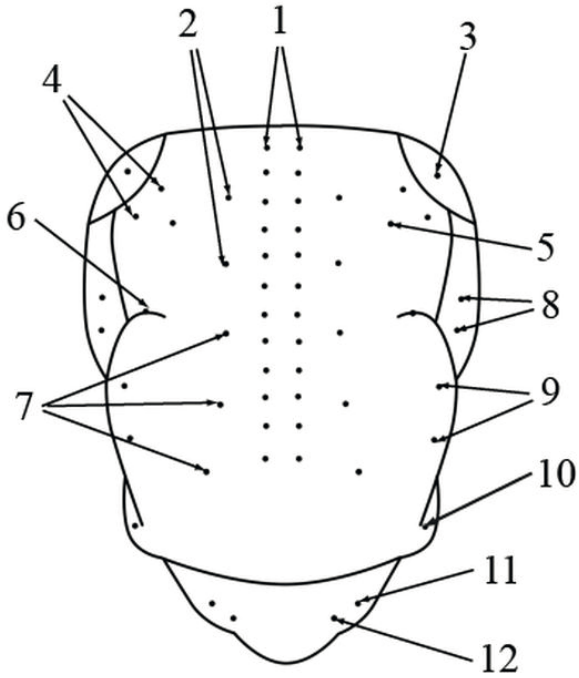

Figure 1. Dolichopodidae mesonotum (dorsal view): (1) acrostichal setae; (2) presutural dorsocentral setae; (3) humeral seta; (4) posthumeral setae; (5) presuturar intraalar seta; (6) sutural deta; (7) postsutural dorsocentral setae; (8) notopleural setae; (9) supraalar setae; (10) postalar seta; (11) lateral scutellar seta; (12) medial scutellar seta.

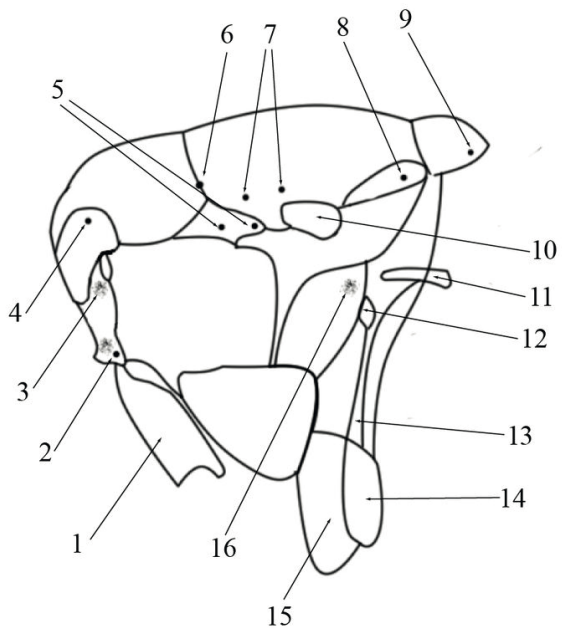

Figure 2. Dolichopodidae thorax (lateral view): (1) Fore coxa; (2) kataproepisternum; (3) anaproepisternum; (4) humeral seta; (5) notopleural setae; (6) sutural seta; (7) supraalar setae; (8) postalar seta; (9) scutellar seta; (10) base of wing; (11) halter; (12) posterior spiracle; (13) ventral metaepisternum; (14) hind coxa; (15) mid coxa; (16) katepimeron.

Table. The studied representative species are used. Irregular series of acrostichal setae are indicated with 'ir', and short lateral scutellar setae are indicated with 's'.

Species	ac	dc	sc
Achalcinae			
Achalcus flavicollis (Meigen, 1824)	2	5	2 + 2s
Apterachalcus borboroides (Oldroyd, 1956)	0	3	2
Australachalcus minutus (Parent, 1933)	2	6	2
Scepastopyga semiflava Grootaert et Meuffels, 1997	2	6	2 + 2s
Xanthina squamifera Robinson, 2003	2	6	2 + 2s
Antyxinae			
Antyx pallida Meuffels et Grootaert, 1991	2ir-1	6	2 + 2s
Antyx fagina Bickel, 1999	0	6	2 + 2s
Babindellinae			
Babindella physoura Bickel, 1987	0	4	2 + 2s
Diaphorinae			
Acropsilus guangdongensis Wang, Yang et Grootaert, 2007	0	5	2
Acropsilus igori Negrobov, 1984	0	5	2 + 2s
Acropsilus luoxiangensis Wang, Yang et Grootaert, 2007	0	5	2
Acropsilus nigricornis Bickel, 1998	0	5	2
Acropsilus perminutus (Parent, 1937)	0	5	2 + 2s
Acropsilus yunnanensis Wang, Yang et Grootaert, 2007	0	6	2
Argyra aripontia Negrobov, 2005	2	6	4
Argyra badjaginae Negrobov et Maslova, 2003	2	5	4
Argyra diaphana (Fabricius, 1775)	2	6	4
Argyra leucocephala (Meigen, 1824)	2	6	4
Argyra pulata Negrobov et Maslova, 2003	2	4	4
Argyra robinsoni Grichanov, 1998	2ir	6	2 + 2s
Argyra serrata Yang et Saigusa, 2002	ir	6	2 + 2
Argyra zlobini Negrobov, Satô et Selivanova, 2012	2	4	6
Asyndetus guangxiensis Zhang, Yang, 2003	2ir	4	2 + 2s
Asyndetus latifrons (Loew, 1857)	2	5	2 + 2s
Asyndetus perpulvillatus Parent, 1926	2	4	2 + 2s
Chrysotus gramineus (Fallen, 1823)	2	6	2 + 2s
Cryptophleps vitiensis Bickel, 2005	0	4	2
Dactylonotus grandicornis Parent, 1934	2	5	2 + 2
Diaphorus disjunctus Loew, 1857	2	5	2 + 2s
Diaphorus dolichocercus Stackelberg, 1947	2	5	2 + 2s
Diaphorus hirsutus Van Duzee, 1921	1	6	4
Diaphorus parenti Stackelberg, 1928	2	5	2 + 2s
Falbouria acorensis (Parent, 1934)	2	6	2
Keirosoma albicinctum Van Duzee, 1929	2	5	2
Lyroneurus caerulescens (Osten Sacken, 1878)	1	5	2 + 2s

Table. (Continued).

Species	ac	dc	sc
Melanostolus longipilosus Negrobov, 1984	2	5	2 + 2s
Melanostolus nigricilius (Loew, 1871)	2	5	2
Nurteria capensis (Parent, 1934)	0	6	2
Phasmaphleps pacifica Bickel, 2005	0	5	2 + 2s
Somillus melanosoma Brethes, 1924	2	6	4
Terpsimyia semicincta (Becker, 1922)	2	5	2
Trigonocera rivosa Becker, 1902	2	5	2 + 2s
Dolichopodinae			
Afrohercostomus natalensis Grichanov, 2010	2	6	2 + 2s
Afroparaclius thompsoni (Grichanov, 2004)	2	6	2 + 2s
Afropelastoneurus martius Grichanov, 2004	2	5	2 + 2s
Ahercostomus jiangchenganus Yang et Saigusa, 2001	2	6	2 + 2s
Ahypophyllus sinensis (Yang, 2005)	2	6	2 + 2s
Allohercostomus rotundatus Yang et Saigusa, 2001	1	6	2 + 2s
Apelastoneurus micrurus Parent, 1933	2	5	2 + 2
Aphalacrosoma postiseta (Yang et Saigusa, 2001)	2	5	2 + 2s
Argyrochlamys impudicus Lamb, 1922	2	6	2 + 2s
Cheiromyia palmaticornis Parent, 1930	2	6	2 + 2s
Dolichopus latilimbatus Macquart, 1827	2	6	2 + 2s
Dolichopus trivialis Haliday, 1832	2	5	2 + 2s
Dolichopus ungulatus (Linnaeus, 1758)	2	6	2 + 2s
Gymnopternus cupreus (Fallen, 1823)	2	6	2 + 2s
Ethiromyia purpuratus (Van Duzee, 1925)	2	6	2 + 2s
Hercostomus angustifrons (Staeger, 1842)	2	6	2 + 2s
Hercostomus celer (Meigen, 1824)	2	6	2 + 2s
Lichtwardtia formosana Enderlein, 1912	2	6	2 + 2s
Lichtwardtia ziczac (Wiedemann, 1824)	2	6	2 + 2s
Metaparaclius subapicalis Becker, 1922	2	6	2 + 2s
Muscidideicus praetextatus (Haliday, 1855)	2	7	2 + 2s
Neohercostomus strictilamellatus (Parent, 1937)	2	5	2 + 2s
Ortochile nigrocoerulea Latreille, 1809	2	6	2 + 2s
Paraclius arcuatus (Loew, 1864)	2	5	2 + 2s
Paraclius argenteus Negrobov, 1984	2	5	2 + 4s
Parahercostomus zhongdianus Yang, 1998	0	6	2 + 2s
Pelastoneurus heteroneurus (Macquart, 1850)	2	5	2 + 4s
Platyopsis maroccans Parent, 1929	2	6	2 + 2s
Poecilobothrus chrysozygos (Wiedemann, 1817)	2	6	2 + 2s
Polymedon partitus Van Duzee, 1929	2	6	2 + 2
Prohercostomus Grichanov, 1997	2	6	2 + 2s
Pseudargyrochlamys michaeli (Grichanov, 2006)	2	6	2

Table. (Continued).

Species	ac	dc	sc
Pseudoparaclius brincki (Vanschuytbroeck, 1960)	2	6	2 + 2s
Pseudopelastoneurus diversifemur (Parent, 1935)	2	6	2 + 2s
Setihercostomus zonalis Yang, Yang et Li, 1998	2	6	2 + 2s
Srilankamyia argyrata Naglis, Grootaert et Wei, 2011	2	6	2 + 2
Steleopyga dactylocera Grootaert et Meuffels, 2001	2	6	2 + 2s
Stenopygium nubeculum Becker, 1922	2	6	2 + 2s
Sybistroma binigra (Yang et Saigusa, 1999)	1	6	2 + 2s
Sybistroma discipes (Germar, 1821)	2	6	2 + 2s
Sybistroma flava (Ding Yang, 1996)	0	6	2 + 2s
Tachytrechus ripicola Loew, 1857	2	6	2 + 2s
Enliniinae			
Enlinia bredini Robinson, 1975	2	8–10	2 + 2s
Harmstonia intricata Robinson, 1964	0	5	2 + 2s
Hydrophorinae			
Abatetia robusta (Parent, 1933)	1	5	2
Acymatopus minor Takagi, 1965	2	6	4 + 2s
Acymatopus oxycercus Masunaga et al., 2005	1	6	4 + 2s
Acymatopus takeishii Masunaga et al., 2005	1–2ir	6	4
Anahydrophorus cinereus (Fabricius, 1805)	2	12	2
Aphrosylus grassator Wheeler, 1897	2	5	2 + 2
Cemocarus griseatus (Curran, 1926)	2	6	4
Conchopus sinuatus Takagi, 1965	2	6	2 + 2s
Coracocephalus strobli Mik, 1892	0	6	4
Cymatopus simplex Parent, 1941	0	5	2 + 2s
Diostracus clavatus Zhu et al., 2007	0	5	2 + 4s
Diostracus maculatus Negrobov, 1980	0	5	2 + 2s
Diostracus punctatus Negrobov, 1977	0	6	2 + 2s
Diostracus spinulifer Negrobov et Tsurikov, 1988	0	6	2 + 4s
Eucoryphus brunneri Mik, 1869	0	6	4
Hydrophorus forcipatus Frey, 1915	2	6	4
Hydrophorus praecox (Lehmann, 1822)	1	6	2 + 4s
Hydrophorus wahlgreni Frey, 1915	2ir	7	4
Hypocharassus gladiator Mik, 1878	2ir	17	4
Hypocharassus pruinosus (Wheeler, 1898)	2ir	17	4
Liancalus genualis Loew, 1861	0	6	6
Liancalus virens (Scopoli, 1763)	1	6	6
Machaerium thinophilus Loew, 1857	2	6	2 + 2s
Melanderia mandibulata Aldrich, 1922	2ir	7	2 + 2s
Nanothinophilus armatus Grootaert et Meuffels, 1998	0	4	2
Orthoceratium lacustre (Scopoli, 1763)	1	7	2 + 2s

Table. (Continued).

Species	ac	dc	sc
Paralleloneurum cilifemoratum Becker, 1902	0	4	4
Peodes forcipatus Loew, 1857	0	6	2 + 2s
Scellus gallicanus Becker, 1909	2ir	8	2
Sphyrotarsus argyrostomus Mik, 1874	1	5	6
Thambemyia rectus Takagi, 1965	1–2ir	6	4
Thinolestris luteola Grootaert et Meuffels, 1988	0	4	2
Thinophilus asiobates Grootaert et Meuffels, 1988	0	6	2
Thinophilus murphi Grootaert et Meuffels, 1988	0	6	2 + 2s
Kowmunginae			
Kowmungia nigrifemorata Bickel, 1987	2	6	2 + 2s
Phacaspis mitis Grootaert et Meuffels, 2001	0	3–4	2 + 2
Medeterinae			
Atlatlia grisea Bickel, 1986	2	5	2 + 2s
Corindia major Bickel, 1986	2	5	2 + 2s
Craterophorus currani Grichanov, 1998	0	5	2 + 2s
Cryptopygiella musaphila Robinson, 1975	2	5	2 + 2s
Cyrturella albosetosa (Strobl, 1909)	0	5	2
Demetera melanesiana Bickel, 1987	2	4	2 + 2s
Dolichophorus kerteszi Lichtwardt, 1902	2	6	2 + 2
Dominicomyia chrysotimoides Robinson, 1975	2	5	2
Euxiphocerus wulfi Parent, 1935	2	6	2 + 2s
Grootaertia kuznetsovi Grichanov, 1999	0	4	2
Maipomyia insolita Bickel, 2004	0	5	2 + 2s
Medetera micacea Loew 1857	2	3	2
Medetera pallipes (Zetterstedt, 1843)	2	4	2 + 2s
Medetera stackelbergiana Negrobov, 1967	2	5	2 + 2
Medetera vidua Wheeler, 1899	2	8	2 + 2s
Medeterella salomonis (Parent, 1941)	2	4	2 + 2s
Medeterites molestus Meunier, 1907	0	6	2
Microchrysotus mirabilis Robinson, 1964	0	5	2
Microcyrtura campsicnemoides Robinson, 1964	0	5	2
Micromedetera archboldi Robinson, 1975	0	5	2
Neomedetera membranacea Zhu et al., 2007	2	4	2
Nikitella vikhrevi Grichanov, 2011	2	5	2 + 2s
Palaeosystenus succinorum (Meunier, 1907)	2	5	2
Papallacta stenoptera Bickel, 2006	0	5	2
Paramedetera papuensis Grootaert et Meuffels, 1997	0	4	2 + 2
Saccopheronta demeteri Grichanov, 1997	2	3	2 + 2
Systenites inclytus (Meunier, 1907)	1	6	2
Systenomorphus katyushae Grichanov, 2010	2	5	2 + 2

Table. (Continued).

Species	ac	dc	sc
Systenoneurus ovechkinae Grichanov, 2010	2	6	2 + 2
Neurigoninae			
Arachnomyia arborum White, 1916	2	5	2
Argentinia annulitarsis Parent, 1931	2	6	2 + 2s
Bickelomyia nigriseta Naglis, 2002	2	6	2 + 2s
Coeloglutus concavus Aldrich, 1896	2	5	2 + 2s
Dactylomyia bicolor Van Duzee, 1933	2	5	2 + 2s
Halteriphorus mirabilis Parent, 1933	2	6	2
Macrodactylomyia magnicauda Naglis, 2002	2	5	2 + 2s
Neotonnoiria maculipennis (Van Duzee, 1929)	2	5	2 + 2s
Oncopygius magnificus Loew, 1873	1	5	2 + 2s
Paracoeloglutus chilensis Naglis, 2001	2	6	2 + 2s
Systenoides paraguayensis Naglis, 2002	2	5	2 + 2s
Tenuopus acrosticalis Curran, 1927	2	5	2 + 2s
Viridigona longicornis Naglis, 2003	2	6	2 + 2s
Peloropeodinae			
Alishanimyia elmohardyi (Bickel, 2004)	0	6	2
Chrysotimus spinuliferus Negrobov, 1978	1	5	2 + 2s
Discopygiella setosa Robinson, 1965	2	5	2
Epithalassius caucasicus Becker, 1918	1ir	6	2 + 2s
Fedtshenkomyia chrysotymoides Stackelberg, 1927	2	5	2 + 2s
Griphophanes gravicaudatus (Grootaert & Meuffels, 1997)	1	5	2
Hadromerella setosa De Meijere, 1916	1	5	4
Hadromerella antennata Hollis, 1964	2ir	5	4
Micromorphus bifrons Robinson, 1964	0	6	2
Nanomyina litorea Robinson, 1964	2	6	2 + 2s
Nepalomyia brevifurcata Yang et Saigusa, 2001	1	6	4
Nepalomyia dytei Hollis, 1964	2	5	2
Nepalomyia tatjanae Negrobov, 1984	2	6	2 + 2s
Peloropeodes brevis (Van Duzee, 1926)	0	6	2 + 2s
Pseudoxanthochlorus micropygus Negrobov, 1977	0	4	2
Vetimicrotes baskunchakensis Grichanov, 2011	0	5	2
Plagionerinae			
Plagioneurus univittatus Loew, 1857	0	5	2 + 2s
Rhaphiinae			
Haplopharyngomyia mutilus (Grootaert et Meuffels, 1998)	1	4	2 + 2s
Mischopyga artifacies Grootaert et Meuffels, 1990	2	5	2 + 2s
Nematoproctus praesectus Loew, 1869	2	6	2 + 2s
Ngirhaphium murphyi Evenhuis et Grootaert, 2002	2	6	2
Physopyga miranda Grootaert et Meuffels, 1990	2	4	2 + 2s

Table. (Continued).

Species	ac	dc	sc
Rhaphium boreale (Van Duzee, 1923)	2	6	2 + 2s
Rhaphium fascipes (Meigen, 1824)	2	7	2 + 2s
Rhaphium heilongjiangense Wang et al., 2005	2	8	2 + 2s
Rhaphium srilankensis Naglis, Grootaert, 2011	2	6	2 + 2s
Urodolichus porphyropoides Lamb, 1922	2	5	2 + 2s
Sciapodinae			
Abbemyia nigrolasciatus (Macquart, 1850)	2	5	2
Amblypsilopus curvus Liu et al., 2012	2	5	2 + 2s
Amblypsilopus nambourensis Bickel, 1994	0	6	2
Amblypsilopus zonatus (Parent, 1932)	0	5	2 + 2s
Amesorhaga femorata (De Meijere, 1916)	2	5	2 + 2s
Austrosciapus connexus (Walker, 1835)	2	5	2 + 2s
Bickelia subparallela Grichanov, 1996	2	5	2 + 2s
Chrysosoma bequaerti (Curran, 1926)	2	5	2 + 2s
Chrysosoma digitatum Yang et Zhu, 2012	2ir	5	2 + 2s
Condylostylus bituberculatus (Macquart, 1842)	2	5	4
Dytomyia sordid Parent, 1928	2	4	2
Ethiosciapus bilobatus Lamb, 1922	2	5	2
Gigantosciapus oldroydi Grichanov, 1997	2	5	2 + 2s
Helixocerus mendosum Lamb, 1929	2	4	2
Heteropsilopus cingulipes (Walker, 1835)	2	6	2 + 2s
Krakatauia evulgata (Becker, 1922)	2	6	2 + 2
Mascaromyia bickeli, Grichanov, 1996	0	4	2
Mesorhaga litoralis Grootaert et Meuffels, 1995	2	5	2 + 2s
Mesorhaga pilosa Negrobov, 1979	2ir	6	2 + 2s
Narrabeenia difficilis (Parent, 1932)	1ir	5	2 + 2
Naufraga hexachaeta (Parent, 1933)	2ir	5	2 + 2
Negrobovia australensis Schiner, 1868	2	5	2 + 2
Parentia malitiosa (Hutton, 1901)	2	5	2 + 2s
Pilbara octava Bickel, 1994	0	4	2
Plagiozopelma brunnipenne Becker, 1922	2	5	2 + 2s
Plagiozopelma flavipodex (Becker, 1922)	2	5	2 + 2s
Pseudoparentia centralis Bickel, 1994	0	4	2
Pseudoparentia tricosa Bickel, 1994	0	4	2
Sciapus bellus (Loew, 1873)	2	6	2 + 2s
Sciapus wiedemanni (Fallen, 1823)	2	6	2 + 2s
Sinosciapus liuae, Yang, 2011	2	5	2 + 2s
Stolidosomatinae			
Pseudosympycnus singularis Parent, 1934	2	6	2
Stolidosoma bicolor Parent, 1934	2	5	2 + 2

Table. (Continued).

Species	ac	dc	sc
Sympycnidelphus sharpi Robinson, 1964	2	5	2
Sympycninae			
Adachia apicenigra (Parent, 1939)	0	5	2
Arciellia dolichostoma (Hardy et Kohn, 1964)	0	5	2
Arciellia xanthopleura Hardy & Kohn, 1964	0	5	2
Brachymyia pulverea Parent, 1933	1	6	2 + 2s
Calyxochaetus vegetus (Wheeler, 1899)	2	6	2 + 2s
Campsicnemus elmoi Evenhuis, 2010	0	3	2
Campsicnemus filipes Loew, 1859	1	4	2 + 2s
Campsicnemus bagachanovae Grichanov, Volfov, 2009	2	5	2 + 2s
Chaetogonopteron appendiculatum De Meijere, 1914	2	6	4
Colobocerus alchymicus Parent, 1933	2	6	6
Elmoia bullata (Hardy & Kohn, 1964)	0	5	2
Emperoptera montgomeryi Evenhuis, 1997	0	3	2
Erebomyia exalloptera Runyon & Hurley, 2004	1	6	2
Filatopus mirabilis (Parent, 1933)	0	6	2
Hercostomoides indonesianus (Hollis, 1964)	1	5	2 + 2s
Humongochela hardyi Evenhuis, 2004	0	5	2 + 2s
Hyptiocheta convexa Becker, 1922	2	6	2 + 2s
Ischiochaetus lenis Parent, 1933	0	6	2
Lamprochromus speciosus (Loew, 1871)	2	5	2 + 2s
Liparomyia sedata White, 1916	1	5	4
Major minor (Parent, 1938)	0	5	2
Micropygus bifenestratus Parent, 1933	0	5	2 + 2s
Neoparentia bisetosa Robinson, 1967	ir	6	2
Nothorhaphium aemulans (Becker, 1922)	1	6	2 + 2s
Phrudoneura abbreviata (Meuffels et Grootaert, 1987)	2	5	2 + 2s
Pinacocerus candiptorum Bickel, 2012	2ir	6	2 + 2
Scotiomyia singaporensis Evenhuis, Grootaert, 2002	2	6	2 + 2s
Scelloides armatus Parent, 1933	0	6	2
Suschania stackelbergi Negrobov, 2003	1	6	2 + 2s
Sympycnus pulicarius (Fallen, 1823)	1	6	2 + 2s
Syntormon bicolorellus (Zetterstedt, 1843)	1	6	2 + 2s
Syntormon zelleri (Loew, 1850)	2	3	2 + 2s
Telmaturgus abidjanensis (Grichanov, 2008)	1	5	2 + 2s
Tetrachaetus bipunctatus Parent, 1933	0	6	2
Teuchophorus elongatus Wang et al., 2006	ir	6	2 + 2s
Teuchophorus monochaetus Negrobov, Grichanov, Shamshev, 1984	ir	6	2
Teuchophorus ussurianus Negrobov et al., 1984	ir	4	2 + 2s
Uropachys hawaiensis Parent, 1934	0	5	2 + 2s

Table. (Continued).

Species	ac	dc	sc
Lamprochromus speciosus (Loew, 1871)	2	5	2 + 2s
Liparomyia sedata White, 1916	1	5	4
Major minor (Parent, 1938)	0	5	2
Micropygus bifenestratus Parent, 1933	0	5	2 + 2s
Neoparentia bisetosa Robinson, 1967	ir	6	2
Nothorhaphium aemulans (Becker, 1922)	1	6	2 + 2s
Phrudoneura abbreviata (Meuffels et Grootaert, 1987)	2	5	2 + 2s
Pinacocerus candiptorum Bickel, 2012	2ir	6	2 + 2
Scotiomyia singaporensis Evenhuis, Grootaert, 2002	2	6	2 + 2s
Scelloides armatus Parent, 1933	0	6	2
Suschania stackelbergi Negrobov, 2003	1	6	2 + 2s
Sympycnus pulicarius (Fallen, 1823)	1	6	2 + 2s
Syntormon bicolorellus (Zetterstedt, 1843)	1	6	2 + 2s
Syntormon zelleri (Loew, 1850)	2	3	2 + 2s
Telmaturgus abidjanensis (Grichanov, 2008)	1	5	2 + 2s
Tetrachaetus bipunctatus Parent, 1933	0	6	2
Teuchophorus elongatus Wang et al., 2006	ir	6	2 + 2s
Teuchophorus monochaetus Negrobov, Grichanov, Shamshev, 1984	ir	6	2
Teuchophorus ussurianus Negrobov et al., 1984	ir	4	2 + 2s
Uropachys hawaiensis Parent, 1934	0	5	2 + 2s

scutellar setae are the most representative. These characters are widely used in taxonomy. Therefore, statistical analysis was carried out on this basis. Other chaetotaxy characters play a secondary role in the diagnosis and were thus considered complementary.

A scatter plot was used for data visualization (Statistica 10). It was necessary to rank the data on the amount and degree of scutellar setae. Data were ranked from 1 to 7 according to the following scutellum criteria: (1) two strong medial setae; (2) two strong medial setae and two very short lateral setae; (3) two strong medial setae and two lateral setae, at least 1/3 of the length of the medial; (4) two strong medial setae and two strong lateral setae; (5) two strong medial setae and four short lateral setae; (6) two strong medial setae, as well as two strong and two short lateral setae; and (7) two strong medial setae and four strong lateral setae.

Ranking the data was similarly performed by a number of acrostichal setae series. It was discovered that more primitive species (e.g., species of the family Empididae and some species of the subfamilies Parathalassinae, Sciapodinae, and Hydrophorinae) all have 2, 3, or 5 irregular series of acrostichal setae (the character states are ranked in the graphs as "–2", "–3", and "–5", respectively). Some species of the subfamily Microphorinae and the family Dolichopodidae are broadly characterized by one irregular series of acrostichal setae (this is designated in the graphs as "–1"). The absence of acrostichal setae and the presence of one or two regular series of acrostichal setae were designated as "0", "1", and "2", respectively.

It should be noted that the number of dorsocentral setae for the considered species varied from 3 to 17 pairs. Most of the Dolichopodidae species are characterized by 5–7 pairs of dorsocentral setae. If there were more than 7 pairs of dorsocentral setae, the variation would be designated as "8", to provide more compact data imaging.

3. Results and discussion

An analysis of the data scattering shows that the ratio of character states was distributed as follows. Most of the Dolichopodidae species are determined by two regular series of acrostichal setae. The combination of two series of acrostichal setae, six pairs of dorsocentral setae, and two strong medial and two short lateral scutellar setae is the most frequent. The combination of two series of acrostichal setae and five pairs of dorsocentral setae is less frequent; nevertheless, it is significant among the considered species (Figure 3).

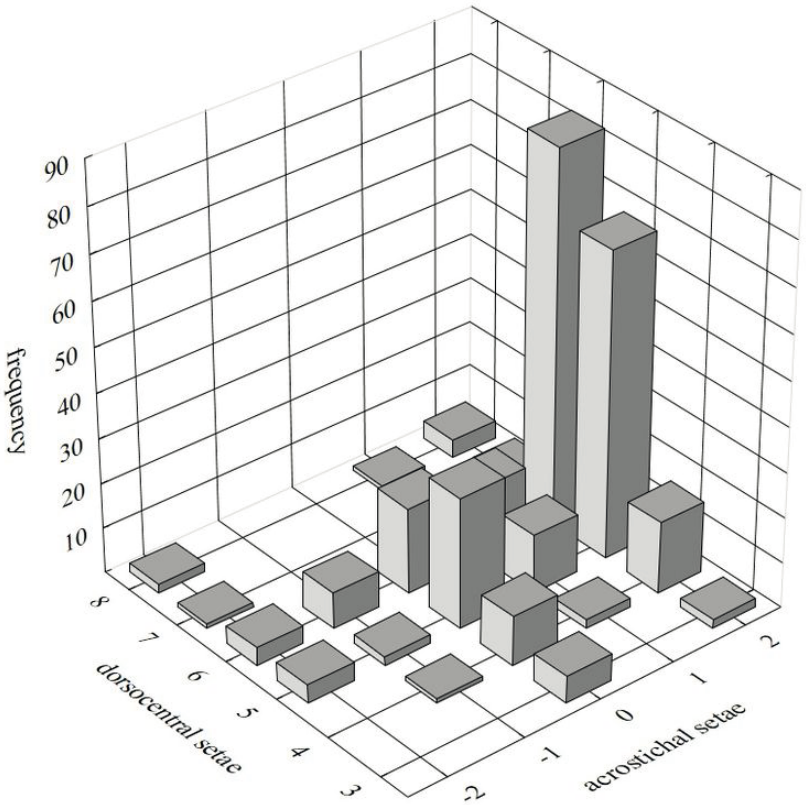

Figure 3. Histogram of combinations of acrostichal and dorsocentral setae in the family Dolichopodidae. The height of the column describes the proportion of species that have this combination of character states.

It was noted that the presence of 3–4 pairs of dorsocentral setae, which was discovered in some species of the subfamilies Medeterinae, Sympycninae, and Kowmunginae, often correlates with the absence of acrostichal setae (Figure 3). However, in this case, there was no correlation with the degree of development of scutellar setae.

Some species of the subfamily Hydrophorinae, such as *Anahydrophorus* (Becker, 1917) and *Hypocharassus* (Mik, 1879), which have two irregular series of acrostichal setae and 12 or 17 pairs of dorsocentral setae, are singled out. The species with developed lateral scutellar setae are frequently observed in this subfamily. This combination of character states is also typical of some Empididae species.

Two strong medial and two short lateral scutellar setae, the length of which is less than 1/3 of the length of the medial (character states numbers are 2 and 3), are the most frequently observed character states of the family Dolichopodidae. The combination of the scutellar setae character states and the number of dorsocentral setae is standard for the family: 5–6 pairs of dorsocentral setae as well as two strong medial and two short lateral scutellar setae, the length of which is less than 1/3 of the length of the medial (Figure 4).

Developed lateral scutellar setae can be combined with any number of dorsocentral setae pairs and any arrangement of acrostichal setae. The presence of six pairs of differently developed scutellar setae (character state numbers are 5 and 6) is quite rare, and is observed only in the subfamily Hydrophorinae. This character state is an intermediate modification among three pairs of developed setae and two pairs, only one pair of which is developed.

A comparative analysis of the morphology of the family Dolichopodidae and other taxa allowed the determination of apomorphic and plesiomorphic character states of thorax chaetotaxy.

In taxa of a higher evolutionary level, acrostichal setae are well developed and arranged in 2 regular series. The presence of two irregular series of acrostichal setae, as seen in some species of the subfamilies Diaphorinae and Hydrophorinae, is the plesiomorphic character state.

The presence of species whose acrostichal setae are arranged in two irregular series on the anterior part of the mesonotum and in one series on the posterior part

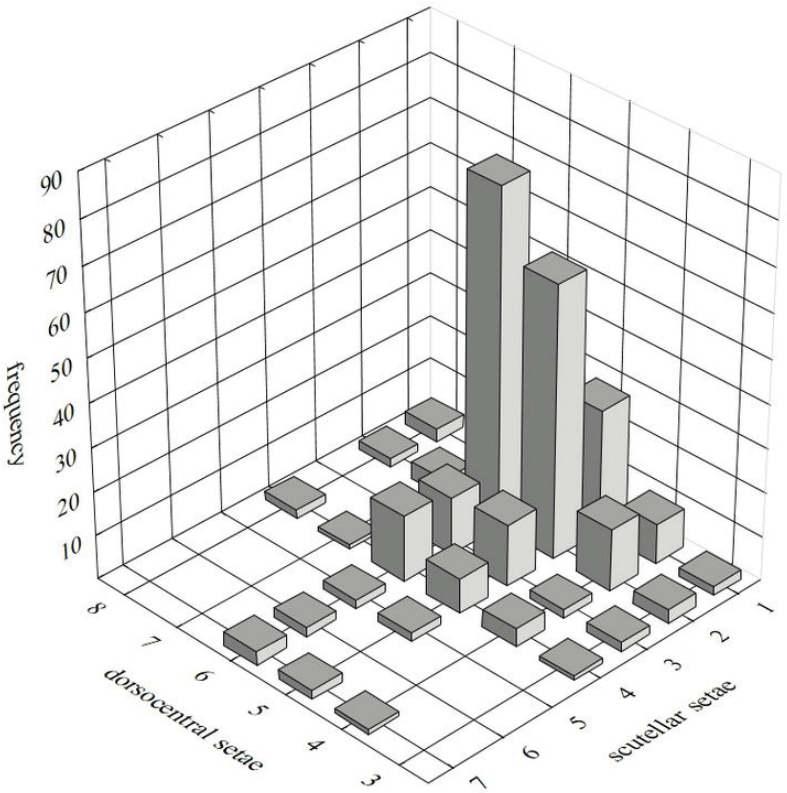

Figure 4. Histogram of combinations of dorsocentral and scutellar setae in the family Dolichopodidae. The height of the column describes the proportion of species that have this combination of character states.

(*Teuchophorus monochaetus* Negr., *Empis limata* Coll.) indicates that one of the evolutionary branches of thorax chaetotaxy has been the formatting of a single series of acrostichal setae. Irregular acrostichal setae arranged in a single series (some species of *Xanthochlorus*; Loew, 1857) can be identified as intermediate modification between two series of irregular acrostichal setae and one regular series.

It should also be noted that some subfamilies (Medeterinae, Achalcinae) are characterized by the presence of two regular series of acrostichal setae or the absence of acrostichal setae. There are species with two evident series of acrostichal setae (*Medetera apicalis* Coll., *M. pallipes* Zett.), and species with reduced acrostichal setae (*M. flavipes* Meig., *M. micacea* Lw.) in the genus *Medetera* (Fischer, 1819). This fact allows the assumption that another branch of evolution was the transition from two regular series of acrostichal setae to the complete absence of acrostichal setae.

Most Dolichopodidae representatives have evident dorsocentral setae, both before the suture (1–2 pairs of dorsocentral setae) and after (3–4 pairs of dorsocentral setae). This modification of character states should be acknowledged as apomorphic. A large number of small dorsocentral setae (as seen in some Hydrophorinae species) constitutes a plesiomorphic character state. A reduction of dorsocentral setae in the anterior part of the mesonotum (as seen in some Sciapodinae species) can be considered the transitional form between species with 6 developed pairs of dorsocentral setae (as seen in the Dolichopodinae species) and those with only 3–4 developed pairs of dorsocentral setae.

Furthermore, the following apomorphic character states were identified: one pair of developed scutellar setae and one postalar seta are present, the anaproepisternum is bare, and the number of supraalar and notopleural setae is 1–2. Plesiomorphic character states are the following: notopleural and supraalar setae are located in a series, more than one postalar seta and several pairs of well-developed scutellar setae are present, and the anaproepisternum has a group of setae or hairs.

The Sciapodinae and Dolichopodinae species have the maximum number of apomorphic character states. However, the presence of setae on the anaproepisternum and

a group of hairs on the ventral part of the metaepisternum above the hind coxa is an important characteristic of the subfamily Dolichopodinae. While the anaproepisternum of the subfamily Sciapodinae species is bare, sometimes having 1–2 strong setae, the plesiomorphic character states of acrostichal and dorsocentral setae are often observed. Many Sciapodinae species have well-developed acrostichal setae, whose length is equal to that of dorsocentral setae; this is also considered a plesiomorphic character state.

In general, the subfamily Hydrophorinae is characterized by plesiomorphic character states, such as short acrostichal setae, often arranged in irregular series. The number of dorsocentral setae is often higher than five pairs, and, in some species, higher than 7 pairs. Morphological abnormalities are found in the subfamilies Hydrophorinae and Diaphorinae: some representatives of these subfamilies have 4–6 pairs of lateral scutellar setae, one or two pairs of which can be developed as medial setae.

The subfamily Diaphorinae has a number of apomorphic character states of thorax chaetotaxy. Thus, representatives of the subfamily often have two series of well-developed acrostichal setae. Dorsocentral setae are also well developed; there are presutular and postsutular dorsocentral setae in the species of Diaphorinae. There is a group of genera in the subfamily that is characterized by bare anaproepisternum.

Chaetotaxy of the anaproepisternum of Diaphorinae species should also be noted, as it allows the selection of the taxonomic unit within the subfamily. Therefore, the anaproepisternum has a group of hairs in the species of the genera *Argyra* (Macquart, 1834), *Dactylonotus* (Parent, 1934), *Falbouria* (Dyte, 1980), *Keirosoma* (Van Duzee, 1929), *Ostenia* (Hutton, 1901), and *Somillus* (Brethes, 1924), whereas it is bare in the other genera of the subfamily.

Representatives of the subfamily Achalcinae often have two evident series of acrostichal setae, whereas many representatives of the subfamily Peloropeodinae, including the type genus of the subfamily, are characterized by one series of acrostichal setae. The acrostichal setae can also be absent. Thorax chaetotaxy of the subfamily Rhaphiinae is better developed in comparison to the subfamily Neurigoninae, but both subfamilies have many common character states. Therefore, in most cases, acrostichal setae are arranged in two regular series, although the acrostichal setae of the Neurigoninae species are shorter, and there are usually 5–6 pairs of dorsocentral setae. Some representatives of these subfamilies have a group of hairs on the kataproepisternum.

Species of the subfamily Medeterinae are remarkable in having a bare anaproepisternum. The variety of chaetotaxy character states within the genus *Medetera* (Fischer, 1819) shows that the genus is paraphyletic. A study by Pollet et al. (2011), based on molecular data, showed the same results. Some researchers use this variety as a foundation for the subdivision of the genus into monophyletic groups of the species (Bickel, 1985, 1987), or to single out the allocation of new genera (Grichanov, 2010, 2011).

The subfamily Sympycninae has a number of plesiomorphic character states of thorax chaetotaxy. In addition to the plesiomorphic character states of the subfamily Xanthochlorinae species, the Sympycninae species often have well-developed lateral scutellar setae.

Our research cannot discover all the relationships among the subfamilies; nevertheless, these results are partly consistent with the data in the literature. Thus, the subfamilies Sciapodinae and Dolichopodinae are well-supported groups and were separated from other subfamilies (Wang et al., 2007; Negrobov et al., 2014). Depending on the analysis technique applied, Rhaphiinae was placed near Medeterinae or Neurigoninae on the phylograms (Lim et al., 2010).

Subsequent analysis of thorax chaetotaxy designates the diagnostic characters for the subfamily level. These criteria should be used in addition to other characters to build a cladistic tree of the family. Character states are summarized based on the present study in the following format: (1) apomorphic state; (0) plesiomorphic state.

1. Acrostichal setae regular biseriate (1); acrostichal setae irregular or uniseriate (0).

2. Acrostichal setae short, sometimes hardly visible (1); acrostichal setae strong, longer than distance between them, sometimes acrostichal setae as long as dorsocentral setae visible (0).

3. 1–2 pairs of presutural dorsocentral setae and 3–4 pairs of postsutural dorsocentral setae are present (1); more than 7 pairs of short dorsocentral setae (0).

4. Anaproepisternum without group of hairs (1); anaproepisternum with group of hairs (0).

5. Group of hairs on ventral part of the metaepisternum absent (1); group of hairs on ventral part of the metaepisternum present (0).

5. Lateral scutellar setae short or absent (1); lateral scutellar setae strong (0).

Our results show that the characters of the subfamilies Dolichopodidae require further discussion, and future taxonomic research needs to use a wider range of morphological characters. More detailed analysis of head, wing, and genitalia morphology will allow for further allocation of diagnostic characters to subfamilies' levels when building a cladistic tree.

Acknowledgment
The work was supported by the Russian Foundation for Basic Research (Grant No. 14-04-00264).

References

Bickel D (1985). A revision of the Nearctic *Medetera* (Diptera: Dolichopodidae). Tech Bull Agr Res Serv 1692: 1-109.

Bickel D (1987). A revision of the Oriental and Australasian *Medetera* (Diptera, Dolichopodidae). Rec Aust Mus 39: 195-259.

Grichanov IY (2010). A new genus of Medeterinae (Diptera: Dolichopodidae) from Baltic amber (Diptera). Caucas Ent Bull 6: 209-212.

Grichanov IY (2011). Three new genera of Medeterinae (Diptera: Dolichopodidae) from Old World tropics and Australasia. Far East Ent 225: 1-16.

Lim SG, Hwang WS, Kutty SN, Meyer R, Grootaert P (2010). Mitochondrial and nuclear markers support the monophyly of Dolichopodidae and suggest a rapid origin of the subfamilies (Diptera: Empidoidea). Syst Ent 35: 59-70.

Marina TA, Negrobov OP (1977). Opyt primenenija priznakov morfologii skleritov grudi dlja sistematiki v semejstve Dolichopodidae (Diptera). Sist Evol Dvukr Nasek L: 67-70 (in Russian).

Marina TA, Negrobov OP (1980). Sravnitel'no-morfologicheskaja harakteristika skleritov grudi Dolichopodidae (Diptera) i ih ispol'zovanie dlja sistematiki. Zool J 59: 1194-1203 (in Russian).

Negrobov OP (1979). Sravnitel'naja harakteristika hetotaksii toraksa rodov semejstva Dolichopodidae (Diptera). Nauch Dokl Vyssh Shk Biol Nauki 8: 46–49 (in Russian).

Negrobov OP, Chursina MA, Selivanova OV (2014) Phylogeny of Dolichopodidae (Diptera) subfamilies. Caucas Ent Bull 10: 185-194 (article in Russian with an abstract in English).

Pollet M, Germann C, Bernasconi MV (2011). Phylogeneric analyses using molecular markers reveal ecological lineages in *Medetera* (Diptera: Dolichopodidae). Can Entomol 143: 662-673.

Simpson P, Woehl R, Usui K (1999). The development and evolution of bristle patterns in Diptera. Development 126: 1349-1364.

Wang M, Zhu YJ, Zhang L, Yang D (2007). A phylogenetic analysis of Dolichopodidae based on morphological evidence (Diptera, Brachycera). Acta Zootaxa Sinica 32: 241-254.