

Diversity of the genus *Dolichopus* Latreille in three different habitats of East Azerbaijan Province, with new records for Iran

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Abstract

Diversity of the genus Dolichopus Latreille in three different habitats of East Azerbaijan Province, with new records for Iran.— The present study is a survey of species diversity of the genus *Dolichopus* in East Azerbaijan province, Iran. The species were collected using a standard entomological net from three habitats (forest, grassland and wetland areas) in north–west Iran in 2013. Based on the data collected, the forest area with the highest diversity indices ($H' = 2.53$, 14 species, and $H' = 2.19$, 10 species, in Chichakli and Keleybar regions respectively) had the most diverse and abundant species, followed by grassland and wetland areas. The dominant species in the study areas were *Dolichopus longitarsis* and *D. simplex*. Besides, three species (*D. siculus*, *D. kiritshenkoi* and *D. plumipes*) were recorded from Iran for the first time. Diagnostic characters and geographical distribution of the species occurring in the studied areas with supplementary figures are provided.

Key words: *Dolichopus*, Species diversity, New records, East Azerbaijan Province, Iran.

Resumen

Diversidad del género Dolichopus Latreille en tres hábitats distintos de la provincia de Azerbaiyán Oriental con nuevos registros en Irán.— El presente trabajo es un estudio sobre la diversidad de especies del género *Dolichopus* en la provincia de Azerbaiyán Oriental (Irán). Dichas especies fueron recolectadas utilizando una red entomológica estándar en tres hábitats (bosque, pradera y zonas pantanosas) en el noroeste de Irán en el año 2013. Según los datos recogidos, el área boscosa con mayores índices de diversidad ($H' = 2,53$, 14 especies, y $H' = 2,19$, 10 especies, en las regiones de Chichakli y Keleybar, respectivamente) presenta la mayor variedad y abundancia de especies, seguida por las praderas y las zonas pantanosas. Las especies dominantes en las áreas estudiadas fueron *Dolichopus longitarsis* y *D. simplex*. Además se registraron tres especies (*D. siculus*, *D. kiritshenkoi* y *D. plumipes*) por primera vez en Irán. Los caracteres diagnósticos y la distribución geográfica de las especies presentes en las áreas estudiadas se acompañan de figuras complementarias.

Palabras clave: *Dolichopus*, Diversidad de especies, Nuevos registros, Provincia de Azerbaiyán Oriental, Irán.

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Introduction

The *Dolichopus* Latreille, 1796, comprises about 630 species, being the largest genus of the family Dolichopodidae. It occurs predominantly in the Holarctic Region with about 290 species known in the Palearctic Region. Adults of this genus are medium–sized, typically less than 8 mm in length, and usually metallic green. Adults and larvae of probably all species are predators.

This genus is morphologically close to *Hercostomus* Loew, 1857, and *Lichtwardtia* Enderlein, 1912, differing from *Hercostomus* in the hind basitarsus bearing 1–3 strong setae dorsally and the pteropleuron having a group of fine hairs in front of the posterior spiracle, and differing from the *Lichtwardtia* in M_{1+2} wing vein being sigmatoid in the middle portion of the distal part, rarely with one stublike vein, and generally much more developed epandrial lobes and cerci in male genitalia (Grichanov, 2011).

Some important studies on this family in the Palearctic region have been done, for example, Grichanov (2007, 2011) prepared keys to East Mediterranean species and Palearctic subfamilies and genera of Dolichopodidae. Pollet (2004) provided a European fauna database. Regarding the dolichopodid distribution in Europe, only very few studies have been done recently (Pollet, 2001; Kechev, 2012).

Fifty–seven species of the family Dolichopodidae have now been recorded from Iran (Grichanov et al., 2010; Khaghaninia et al., 2013; Gharajedaghi et al., in press). Grichanov et al. (2010) reported eight species of the genus *Dolichopus*. Khaghaninia et al. (2013) and Gharajedaghi et al. (in press) reported 10 species of this genus from Iran. Khaghaninia et al. (2014) described a new species of the *Dolichopus plumipes* species group.

This is the first study of species diversity of the genus *Dolichopus* in Iran. As the fauna of the family Dolichopodidae is poorly known in Iran, further studies are needed.

Materials and methods

Study areas

Materials were collected from grassland, semi–aquatic and forest habitats in four regions (Chichakli, Keleybar, Kandovan and Qurigol) of East Azerbaijan Province, Iran, in 2013. Chichakli and Keleybar are located in the Qaradagh Forest (fig. 1). Qaradagh Forest is situated in north western Iran, bordering with Armenia and Azerbaijan, and belonging to the Iranian Highlands bound in the north by the Lesser Caucasus. Its geographic latitudes and longitudes are 38° 40.524' to 39° 08.562' N, 46° 39.256' to 47° 02.652' E. This area has rangelands and forests, rivers and springs at an altitude varying from 256 m in the vicinity of Araz river to 2,896 m, and it covers an area of 78,560 hectares. It is registered in the UNESCO World Heritage List since 1976. The Kandovan valley is one of the longest valleys in the Sahand mountain chain. It is about 12 km in length and is located in south east of East Azerbaijan Province, about 35.5 km from Tabriz city, with coordinates 37° 46.370' to 37° 76.564' N and 46° 16.323' to 46° 45.253' E at varying altitude from 1,860 to 3,110 m

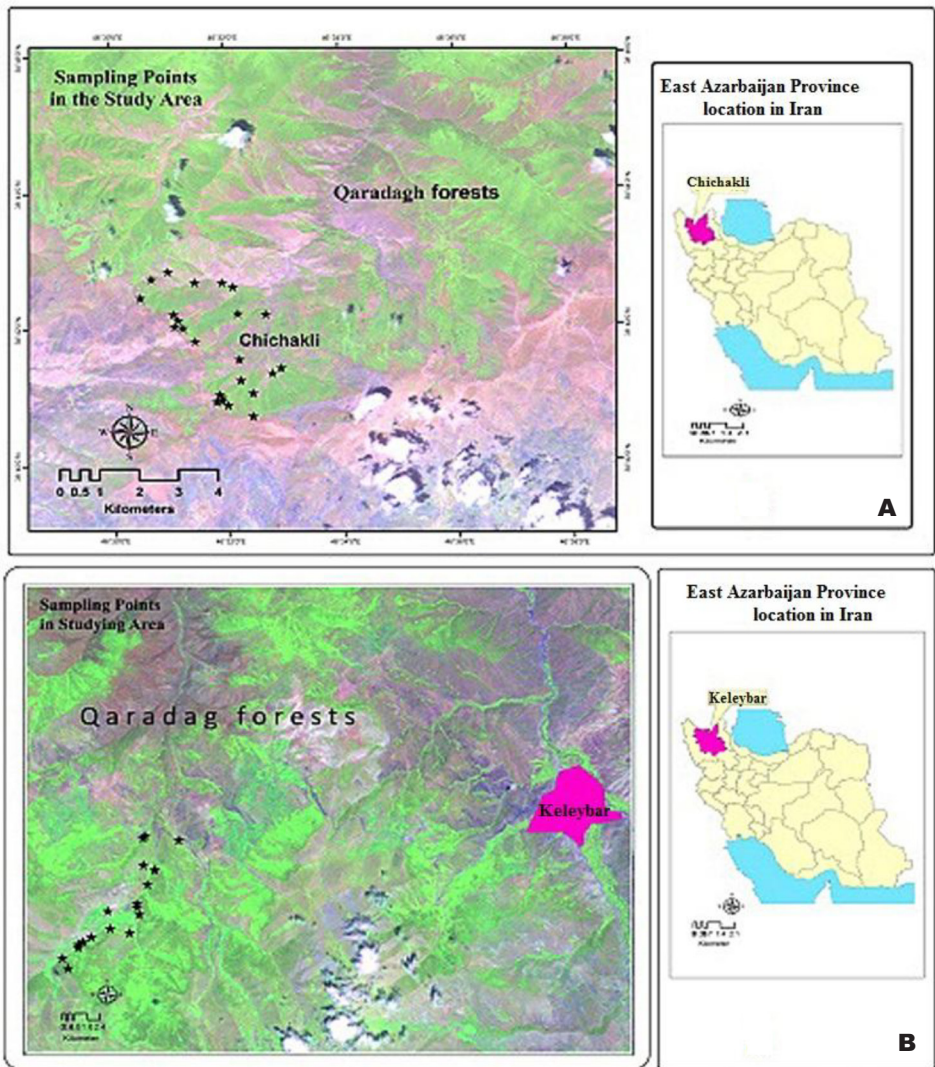


Fig. 1. Location of sampling points on satellite image (SPOT) of Qaradag forests: A. Chichakli region; B. Keleybar region.

Fig. 1. Localización de los puntos de muestreo en los bosques de Qaradag en una imagen de satélite (SPOT): A. Zona de Chichakli; B. Zona de Keleybar.

(fig. 2A). It is a mixed area that has rich grass lands with various species of Asteraceae, Apiaceae, Leguminaceae, Poaceae and Ranunculaceae, and various crops are also cultivated in this region.

The Qurigol (Ghorighol) region is a wetland area located on 200 hectares with a small lake with fresh to brackish water, with associated marshes in the steppe uplands of northwestern Iran. There are extensive areas of reed beds; some species of Asteraceae, Cyperaceae, Lamiaceae, Plantaginaceae, Poaceae and Ranunculaceae are also found in this area. It

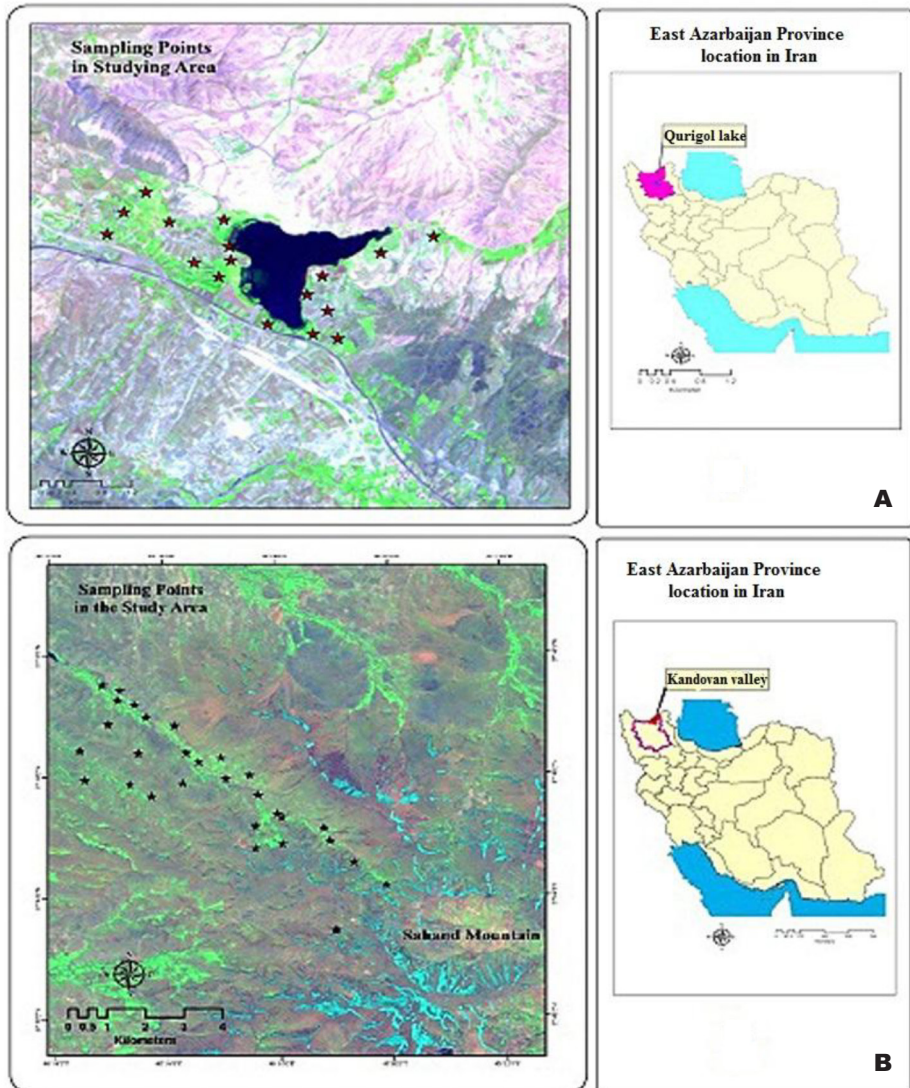


Fig. 2. Location of sampling points on satellite image (SPOT): A. Qurigol region; B. Kandovan valley.

Fig. 2. Localización de los puntos de muestreo en una imagen de satélite (SPOT): A. Zona de Qurigol; B. Valle de Kandovan.

is situated at about 40 km east-southeast of Tabriz city with coordinates $37^{\circ} 55.254'$ to $37^{\circ} 56.542'$ E, $46^{\circ} 42.257'$ to $46^{\circ} 54.253'$ N at varying altitude from 1,833 m to 1,950 m (fig. 2B). The surrounding area is semi-arid, and wheat is cultivated on the west and on damp grasslands in the southwest.

Methods of collecting and identifying the specimens

The sweeping net with diameter of 40 cm (standard size and method based on Martin (1977) was used for sampling studied areas in 2013. Samples were collected every three weeks by making 100 sweeps with the net over a distance of about 100 m. Sampling was also restricted to the period between 10.00 h and 16.30 h, and the sampling order of the fields varied between weeks. Every site was sampled between six and eight times from late May to early September. The specimens are deposited at the Insect Museum of Tabriz University (IMTU). The distribution part of the list includes adjacent countries and notes on the general distribution for each species after Grichanov (2007) and Grichanov's online database DoliBank (2003–2013) (available from <http://dolicho.narod.ru/Genera3.htm>).

Methods of data analysisStudy of the species structure and composition

Heydemann's (Weigmann, 1973) classification was used to evaluate the dominance structure. This classification has five degrees of dominance: eudominant species, those making up more than 30% of all the collected specimens, dominant (10–30%), subdominant (5–10%), rare (1–5%) and subrare (less than 1%).

Measurement of alpha diversity

Data analysis was calculated by SDR (Species Diversity and Richness) software, version 4.0 (Seaby & Henderson, 2006). The following diversity indices were used to describe the species diversity in the studied area according to Magurran (2004):

1. Shannon–Wiener:

$$H = -\sum_{i=1}^S p_i \log_e p_i,$$

where: p_i is the proportion of individuals in each species and S the species number (species richness).

2. Simpson's D :

$$D = \frac{1}{\sum_{i=1}^S p_i^2},$$

$$p_i^2 = \frac{N_i(N_i - 1)}{N_t(N_t - 1)} \quad p_i^2 = \left(\frac{N_i}{N_t} \right)^2,$$

where: N_i is the number of individuals in each species and N_t is the total individuals in the sample.

3. Pielou J evenness index:

$$J = H' / \log(S),$$

where H' is the Shannon–Wiener function and S is the total number of species observed.

Similarity index

The Sørensen index, also known as Sørensen's similarity coefficient, is a statistic used to compare the similarity of two samples. The Sørensen coefficient is mainly useful for ecological community data (Magurran, 2004):

$$S_s = \frac{2a}{2a + b + c},$$

where S_s is the Sørensen similarity index, a the common species in the region A and B; b the number of species in the region A that do not exist in the region B; c the number of species in the region B that do not exist in region A. This index will be equal to one, when the sum of the species of two habitats is quite similar.

Results

In this study, 17 species of the genus *Dolichopus* were collected from the East Azerbaijan Province, of which three species (*D. siculus*, *D. kiritshenkoi* and *D. plumipes*) are newly reported for the Iranian insect fauna. Species are listed in alphabetic order.

Subfamily Dolichopodinae

Genus *Dolichopus* Latreille, 1796

***Dolichopus austriacus* Parént, 1927**

Material examined

Chichakli: 5♂, 38° 37.169' N – 46° 26.536' E, 1,534 m, 21 VII 2013. Leg. Khaghaninia.

Distribution

Austria, Estonia, Finland, Germany, Romania, Russia (Astrakhan), Sweden and Uzbekistan (Grichanov, 2007); Iran (Gharajedaghi et al., in press).

***Dolichopus campestris* Meigen, 1824**

Material examined

Keleybar: 5♂♂, 38° 51.548' N – 46° 59.007' E, 1,783 m, 1 VII 2013. Chichakli, 5♂♂, 38° 30.437' N, 46° 36.447' E, 1,724 m, 15 VI 2013. Kandovan, 3♂♂, 37° 44.254' N – 46° 19.256' E, 3,005 m, 16 VIII 2013. Leg. Khaghaninia.

Distribution

Algeria, Armenia, Austria, Belarus, Belgium, Czech, Denmark, Egypt; Estonia, Finland, France, Georgia, Germany, Hungary, Ireland, Italy, Kazakhstan, Kyrgyzstan, Latvia, Lithuania, Netherlands, Norway, Poland, Romania, Russia (Karelia, Leningrad, Novgorod, Alania, Kabardino–Balkaria, Krasnodar, Altai, Kamchatka, Khabarovsk and Primorskii Terr.), Slovakia, Sweden, Switzerland, UK, Ukraine (Carpathian Mountains, Odessa) (Grichanov, 2007); Iran (Gharajedaghi et al., in press).

***Dolichopus clavipes* Haliday, 1832**

Material examined

Chichakli: 5♂♂, 38° 39.546' N – 46° 16.790' E, 1,059m, 12 VII 2013. Keleybar: 5♂♂, 38° 51.548' N – 46° 59.007' E, 1,783 m, 1 VII 2013. Kandovan: 2♂♂, 37° 46.231' N – 46° 15.012' E, 2,341 m, 20 VII 2013. Leg. Khaghaninia.

Distribution

S Russia (Krasnodar), Ukraine (Kherson, Odessa, Zaporizhzhya), W and N Europe; E Russia (Buryatia, Irkutsk Region, Krasnoyarsk Terr., Yakutia), China, Kazakhstan, Mongolia, Tajikistan, Uzbekistan; Iran (Grichanov et al., 2010).

***Dolichopus griseipennis* Stannius, 1831**

Material examined

Qurigol: 1♂, 37° 55.028' N – 46° 41.244' E, 1,847 m, 22 VIII 2013. Leg. Khaghaninia.

Distribution

Algeria, Armenia, Azerbaijan, Austria, Belgium, Bulgaria, Bosnia and Herzegovina, Croatia, Cyprus, Czech, Denmark, Estonia, Finland, France, Georgia, Germany, Great Britain, Greece incl. Crete, Hungary, Iran, Ireland, Israel, Italy, N Kazakhstan, Lithuania, Luxembourg, ?Macedonia, Morocco, Netherlands, Norway, Poland, Romania, Russia (Adygea, Krasnodar, Moscow), Slovakia, ?Slovenia, Spain incl. Balearic Is., Sweden, Switzerland, Tunisia, Turkey, “Yugoslavia”; Middle Asia (Grichanov, 2007); Iran (Grichanov et al., 2010).

***Dolichopus immaculatus* Becker, 1909**

Material examined

Chichakli: 2♂♂, 38° 39.546' N – 46° 16.790' E, 1,059 m, 12 VII 2013. Leg. Khaghaninia.

Distribution

Austria, Czech Republic, France, Israel and Poland (Grichanov, 2007); Iran (Gharajedaghi et al., in press).

***Dolichopus kiritshenkoi* Stackelberg, 1927 (fig. 3)**

Material examined

Kandovan: 6♂♂, 37° 45.012' N – 46° 18.234' E, 2,844 m, 25 VI 2013. Leg. Khaghaninia.

Diagnosis

Lower postocular cilia black; antenna entirely black (fig. 3B); 5th segment of fore tarsus without apical excision, elongate–ovate (fig. 3D); fore tibia yellow; femora entirely or largely black; mid femur black except apex; hind femur with long white ventral cilia; mid tarsus simple (fig. 3A); hypopygium of male as (fig. 3C).

Distribution

Georgia (Grichanov, 2007); new to Iranian insect fauna.

***Dolichopus longitarsis* Stannius, 1831**

Material examined

Chichakli: 7♂♂, 38° 37.169' N – 46° 26.536' E, 1,534 m, 21 VII 2013; 5♂♂, 38° 39.546' N – 46° 16.790' E, 1,059 m, 15 VI 2013. Keleybar: 8♂♂, 38° 50.903' N – 47° 00.367' E,

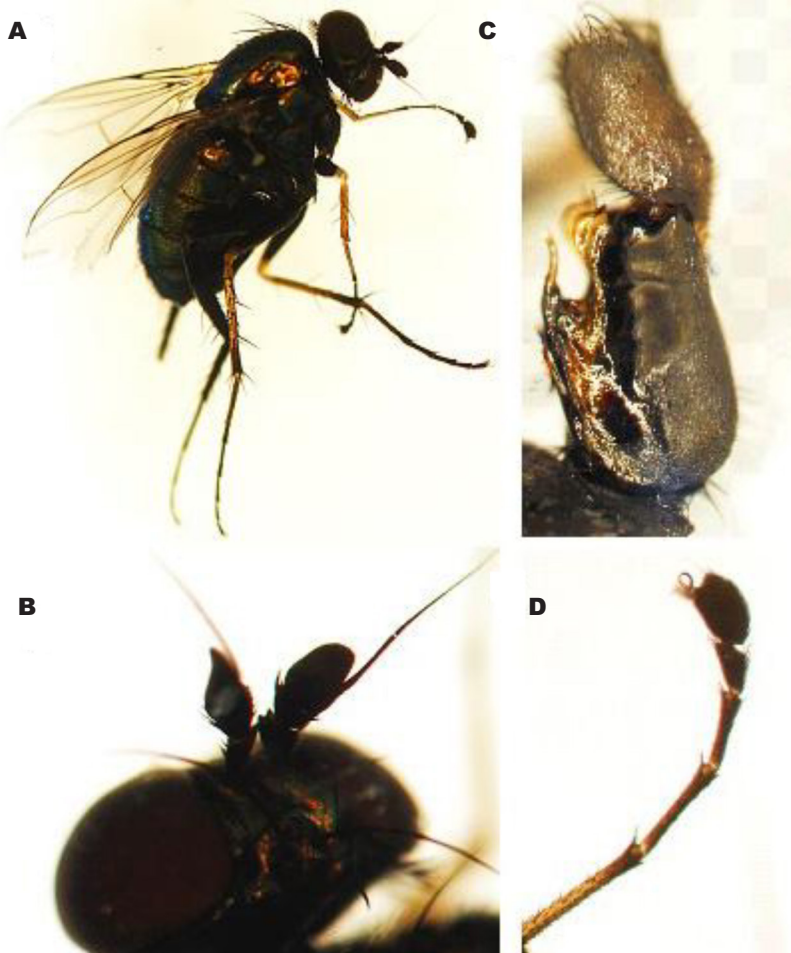


Fig. 3. *Dolichopus kiritshenkoi*, male: A. Habitus, lateral view; B. Head, dorsal view; C. Hypopygium, lateral view; D. Front tarsus, lateral view.

Fig. 3. *Dolichopus kiritshenkoi*, macho: A. Habitus, vista lateral; B. Cabeza, vista dorsal; C. Hipopigio, vista lateral; D. Tarso anterior, vista lateral.

1,524 m, 12 VI 2013. Kandovan: 11♂♂, 37° 45.012' N – 46° 18.234' E, 2,844 m, 25 VI 2013. Leg. Khaghaninia.

Distribution

Austria, Belarus, Belgium, Demark, Estonia, Finland, France, Georgia, Germany, Hungary, Ireland, Kazakhstan, Latvia, Lithuania, Netherlands, Norway, Poland, Romania, Russia (Karelia, Leningrad, Moscow, Nenetsia, Pskov, Vologda, Voronezh), Slovakia, Spain, Sweden, Switzerland, Turkey, UK and Ukraine (Cherkasy); Iran (Khaghaninia et al., 2013).

***Dolichopus malekii* Grichanov, Khaghaninia & Gharajedaghi, 2014 (fig. 4)**

Material examined

Chichakli: 6♂♂, 38° 39.257' N – 46° 31.235' E, 2,140 m, 15 VI 2013; 4♂♂, 2♀♀, 38° 37.169' N – 46° 26.536' E, 1,534 m, 21 VII 2013; 5♂♂, 38° 37.024' N – 46° 26'.356' E, 1,534 m, 15 VI 2013. Keleybar: 5♂♂, 38° 51.077 N – 46° 59.932' E, 1,367 m, 1 VII 2013. Leg. Khaghaninia.

Diagnosis

Antenna black, with scape yellow beneath (fig. 4B); face yellow; lower postocular cilia pale; wing costa with punctiform thickening at R1, lower calypter with entirely black cilia; all tarsi simple, fore tibia without apicoventral seta, mid tibia with long clear white dorsal area in distal third (fig. 4D), hind basitarsus with two dorsal setae, hind femur without fringe of long hairs, at most with hairs hardly more than half as long as greatest diameter of femur; hypopygium of male as (fig. 4C). Female is similar to male except lacking male secondary sexual characters, otherwise as follows: face whitish–grey; postpedicel as long as high; legs simple. It differs from the closest species in blackish–brown apex of hind femur.

Remarks

The species was described by males only (Khaghaninia et al., 2014). This is the first description of the female.

***Dolichopus nubilus* Meigen, 1824**

Material examined

Chichakli: 7♂♂, 38° 39.546' N – 46° 16.790' E, 1,059 m, 21 VI 2013. Leg. Khaghaninia.

Distribution

Armenia, Austria, Azerbaijan, Belgium, Bulgaria, China (Xinjiang), Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece incl. Crete, Hungary, Ireland, Italy, Kazakhstan, Kyrgyzstan, Latvia, Netherlands, Norway, Poland, Romania, Russia (Karelia, Leningrad, Adygea, Krasnodar, Rostov), Slovakia, Spain, Sweden, Switzerland, Tajikistan, Ukraine (Kherson, Odessa), UK, Uzbekistan (Grichanov, 2007), Iran (Grichanov et al., 2010).

***Dolichopus perversus* Loew, 1871**

Material examined

Chichakli: 5♂♂, 38° 37.169' N – 46° 26.536' E, 1,534 m, 15 VI 2013. Qurigol: 15♂♂, 37° 54.975' N – 46° 41.120' E, 1,943 m, 27 VI 2013. Keleybar: 1♂, 38° 51.548' N – 46° 59.007' E, 1,783 m, 1 VII 2013/ Leg. Khaghaninia.

Distribution

Abkhazia, Armenia, Israel, Turkey, Tajikistan, N Kazakhstan (Grichanov, 2007), Iran (Grichanov et al., 2010).

***Dolichopus plumipes* (Scopoli, 1763) (fig. 5)**

Musca plumipes Scopoli, 1763

Material examined

Chichakli: 3♂♂, 38° 34.167' N – 46° 30.091' E, 1,907 m, 15 VI 201; 8♂♂, 38° 30.437' N – 46° 36.447' E, 1,724 m, 15 VI 2013. Keleybar: 5♂♂, 38° 51.548' N – 46° 59.007' E, 1,783 m, 1 VII 2013. Leg. Khaghaninia.



Fig. 4. *Dolichopus malekii*, male: A. Habitus, lateral view; B. Head, lateral view; C. Hypopygium, lateral view; D. Mid tibia, dorsal view.

Fig. 4. *Dolichopus malekii*, macho: A. Habitus, vista lateral; B. Cabeza, vista lateral; C. Hipopigio, vista lateral; D. Parte media de la tibia, vista dorsal.

Diagnosis

Lower postocular cilia pale; antennal scape and pedicel yellow, postpedicel whitish beneath (fig. 5B); femora yellow; mid tibia thin, yellow, whitish at apex, with longitudinal narrow dark streak anterodorsally; mid basitarsus pennate anterodorsally and posteroventrally without white or silvered segments, plumage of mid basitarsus shorter than double diameter of basitarsus (fig. 5C); apex of hind tibia and whole hind basitarsus black or brownish black; hypopygium as (fig. 5D).

Distribution

Bulgaria, Georgia, Greece, Romania, S Russia (Adygea, Kabardino–Balkaria, Karachai–Cherkessia, Krasnodar, Rostov), Turkey, Ukraine (Cherkasy, Kherson, Odessa, Carpathia) (Grichanov, 2007); *D. plumipes* is very common across the Holarctic Realm, also reported from adjacent territories of the Orient and Neotropics. New to Iranian insect fauna.

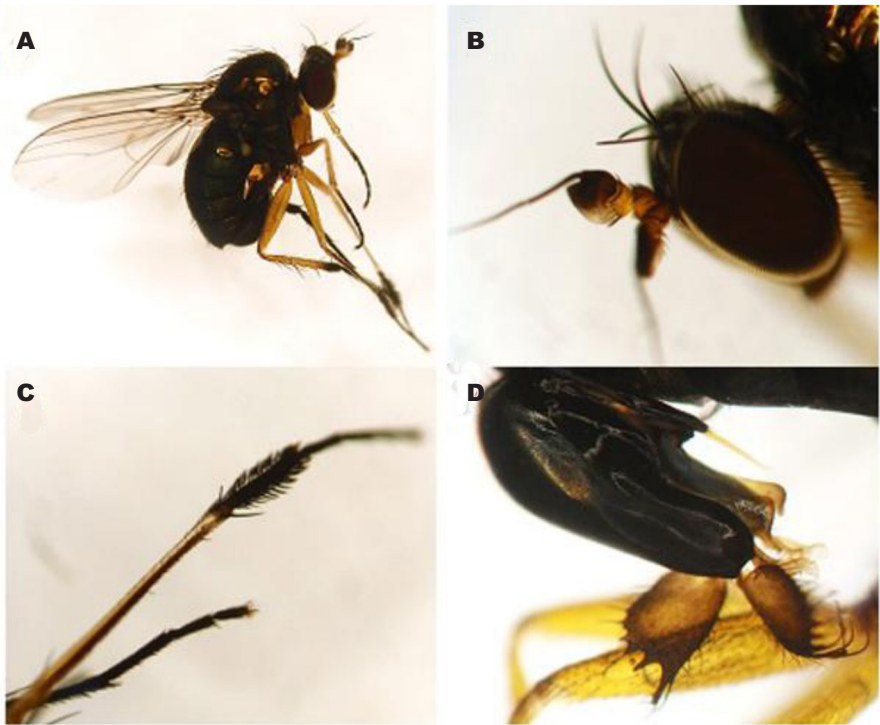


Fig. 5. *Dolichopus plumipes*, male: A. Habitus, lateral view; B. Head, dorsolateral view; C. Mid tibia and basitarsus, dorsal view; D. Hypopygium, lateral view.

Fig. 5. *Dolichopus plumipes*, macho: A. *Habitus, vista lateral*; B. *Cabeza, vista dorso-lateral*; C. *Parte media de la tibia y basitarso, vista dorsal*; D. *Hipopigio, vista lateral*.

Remarks

Some specimens have taxonomically insignificant colour variations including the cercus colour (fig. 6D), representing probably demasculinised forms due to the effect of parasitic nematodes on the secondary sexual diagnostic features (Kahanpää, 2008).

Dolichopus salictorum Loew, 1871

Material examined

Qurigol: 2♂♂, 37° 54.231' N – 46° 42.235' E, 1,921 m, 6 VII 2013. Leg. Khaghaninia.

Distribution

Bulgaria, Czech Republic, Hungary, Italy, Poland, Romania, Russia (Krasnodar, Voronezh), Slovakia and Ukraine (Lviv, Odessa) (Grichanov, 2007), Iran (Khaghaninia et al., 2013).

Dolichopus siculus Loew, 1859 (fig. 6)

Material examined

Keleybar: 7♂♂, 38° 50.903' N – 47° 00.367' E, 1,524 m, 10 VII 2013. Chichakli: 7♂♂, 38° 34.167' N – 46° 30.091' E, 1,907 m, 15 VI 2013. Leg. Khaghaninia.

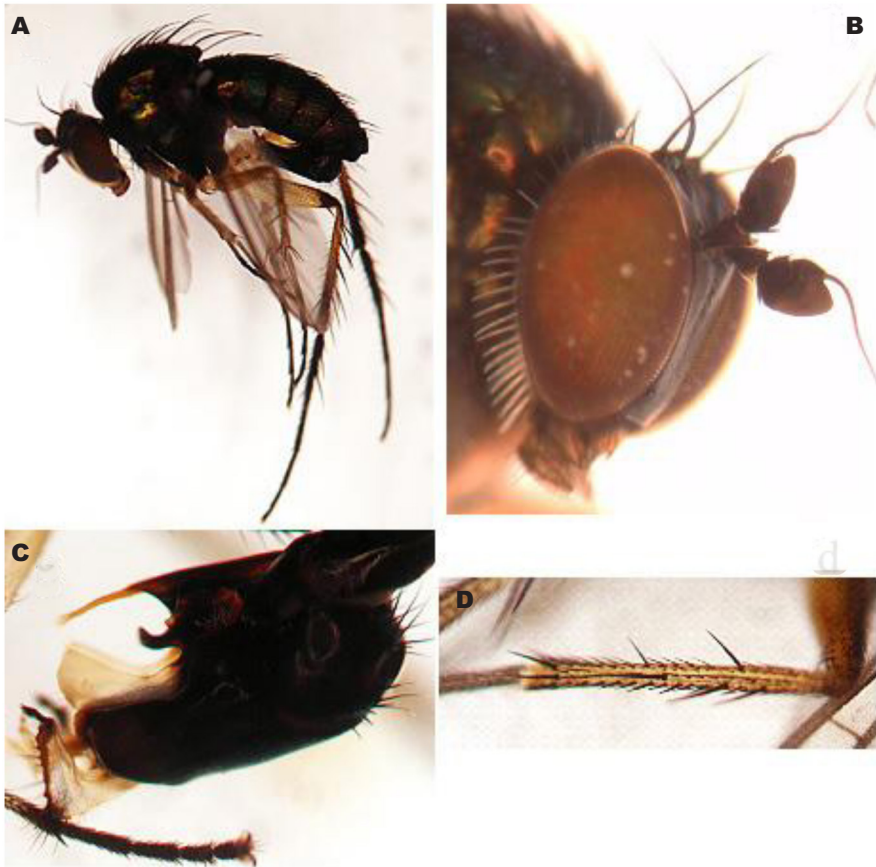


Fig. 6. *Dolichopus siculus*, male: A. Habitus, lateral view; B. Head, lateral view; C. Hypopygium, lateral view; D. Front tibia, dorsolateral view.

Fig. 6. *Dolichopus siculus*, macho: A. Habitus, vista lateral; B. Cabeza, vista lateral; C. Hipopigio, vista lateral; D. Tibia anterior, vista dorso–lateral.

Diagnosis

Lower postocular cilia pale; antenna entirely black, at most scape reddish ventrally at apex (fig. 6B); lower calypter with entirely black cilia; all tarsi simple; fore tibia without apicoventral seta (fig. 6D); fore femur dark; mid tibia yellow; hind femur apically black or brown without fringe of long hairs; hind basitarsus with at least 2 dorsal setae; hypandrium without dorsal tooth; cercus crescent, with long cilia and small distoventral process (fig. 6C).

Distribution

Bulgaria, Israel, France, Italy (Grichanov, 2007). New to Iranian insect fauna.

Dolichopus signifer Haliday, 1832

Material examined

Keleybar: 4♂♂, 38° 51.548' N – 46° 59.007' E, 1,783 m, 10 VII 2013. Chichakli: 6♂♂,

38° 34.167' N – 46° 30.091' E, 1,907 m, 15 VI 2013. Kandovan: 4♂♂, 37°46.231' N – 46° 15.012' E 2,341 m, 20 VII 2013. Leg. Khaghaninia.

Distribution

Armenia, Bulgaria, Georgia, Greece incl. North Aegean, Romania, S Russia (Kabardino–Balkaria, Krasnodar, Rostov), Turkey, Ukraine (Crimea, Odessa), Europe, Afghanistan, Azores, Morocco, Tajikistan, Turkmenistan, Uzbekistan (Grichanov, 2007); Iran (Grichanov et al., 2010).

***Dolichopus simplex* Meigen, 1824**

Material examined

Chichakli: 7♂♂, 38° 30.342' N – 46° 37.234' E, 1,059 m, 15 VI 2013. Keleybar: 8♂♂, 38° 51.077' N 46° – 59.932' E, 1,367 m, 12 VI 2013. Kandovan: 7♂♂, 37° 45.012' N – 46° 18.234' E, 2,844 m, 25 VI 2013. Qurigol: 4♂♂, 37° 54.234' N – 46° 42.325' E, 1,921 m, 6 VI 2013. Leg. Khaghaninia.

Distribution

Georgia, Romania, S Russia (Karachai–Cherkessia, Krasnodar, Rostov), Ukraine (Cherkasy, Odessa), all Europe, Kazakhstan, E Russia (Orenburg, Yakutia) (Grichanov, 2007), Iran (Khaghaninia et al., 2013).

***Dolichopus subpennatus* d'Assis Fonseca, 1976**

Material examined

Keleybar: 3♂♂, 38° 51.077' N – 46° 59.932' E, 1,367 m, 1 VII 2013. Chichakli: 7♂♂, 38° 30.342' N – 46° 37.235' E, 1,689 m, 15 VI 2013. Leg. Khaghaninia.

Distribution

Czech Republic, Denmark, Estonia, Finland, Germany, Ireland, Netherlands, Norway, Romania, Russia (Adygea), Slovakia, Sweden and UK (Grichanov, 2007), Iran (Gharajedaghi et al., in press).

***Dolichopus ungulatus* (Linnaeus, 1758)**

Material examined

Chichakli: 3♂♂, 38° 30.342' N – 46° 37.324' E, 1,689 m, 15 VI 2013. Leg. Khaghaninia.

Distribution

Bulgaria, Georgia, Romania, S Russia (Adygea, Alania, Kabardino–Balkaria, Karachai–Cherkessia, Krasnodar) and Ukraine (Odessa, Carpathia); Palaearctic and Nearctic Regions (Grichanov, 2007); Iran (Gharajedaghi et al., in press).

Distribution of species in different sampling areas

In all, 206 specimens belonging to 17 species were captured (annex). Based on Heydemann's classification (Weigmann, 1973), the species *D. malekii* was the dominant species in Chichakli followed by *D. plumipes* and *D. longitarsis*; the species *D. longitarsis*, *D. simplex*, *D. siculus* and *D. plumipes* dominated in Keleybar; the species *D. longitarsis*, *D. simplex* and *D. signifer* were dominant species in Kandovan; while *D. perversus* and *D. simplex* were eudominant and dominant species in Qurigol region. *D. immaculatus*, *D. salictorum*, *D. ungulatus* and *D. griseipennis* were defined as rare species (table 1).

Table 1. Comparison of relative abundance of species of the genus *Dolichopus* in regions of East Azerbaijan Province, Iran.

Tabla 1. Comparación de la abundancia relativa de especies del género *Dolichopus* en las zonas de la provincia de Azerbaiyán Oriental, Irán.

Species	Study areas			
	Chichakli	Kandovan	Keleybar	Qurigol
<i>Dolichopus austriacus</i>	5.25	0	0	0
<i>Dolichopus malekii</i>	17.35	0	9.09	0
<i>Dolichopus campestris</i>	5.25	10	9.09	0
<i>Dolichopus clavipes</i>	5.25	6.67	9.09	0
<i>Dolichopus griseipennis</i>	0	0	0	4.76
<i>Dolichopus immaculatus</i>	2.35	0	0	0
<i>Dolichopus kiritshenkoi</i>	0	20	0	0
<i>Dolichopus longitarsis</i>	12.58	26.67	20	0
<i>Dolichopus nubilus</i>	5.25	0	0	0
<i>Dolichopus perversus</i>	5.25	0	1.82	71.43
<i>Dolichopus plumipes</i>	10.45	0	10.91	0
<i>Dolichopus salictorum</i>	0	0	0	4.76
<i>Dolichopus siculus</i>	7.17	0	12.72	0
<i>Dolichopus signifier</i>	6.24	13.33	7.27	0
<i>Dolichopus simplex</i>	7.17	23.33	14.55	19.05
<i>Dolichopus subpennatus</i>	7.17	0	5.46	0
<i>Dolichopus ungulatus</i>	3.26	0	0	0

Species diversity in different areas of East Azerbaijan Province

Alpha diversity indices for the different areas are shown in table 2. The species number was highest in Chichakli, followed by Keleybar and Kandovan, while Qurigol had the lowest species number. The diversity and evenness indexes showed a significant difference among the studied areas at 5% level ($P < 0.05$). They were the highest in Chichakli followed by Keleybar and Kandovan, while Qurigol had the lowest diversity (table 2).

Species composition similarity between areas

The similarity indices for the studied areas are shown in figure 7. The highest similarity (0.83) was observed between Chichakli and Keleybar, followed by Kandovan and Keleybar (0.62); while the least similarity (0.20) was observed between Kandovan and Qurigol, followed by Chichakli and Qurigol (0.22).

Discussion

The highest biodiversity was found in forestry areas (Chichakli and Keleybar) that have the highest diversity and species number. This could be related to the rich vegetation and high

Table 2. Shanon–Wiener and Simpson diversity indices and Pielou *J* evenness index for the genus *Dolichopus* in regions of East Azerbaijan Province, Iran.

Tabla 2. Índices de diversidad de Shanon–Wiener y Simpson e índice de equidad de Pielou *J* para el género *Dolichopus* en las zonas de la provincia de Azerbaiyán Oriental, Irán.

Diversity indices	Study areas			
	Chichakli	Kandovan	Keleybar	Qurigol
Species number	14	6	10	4
Shanon–Wiener (<i>H'</i>)	2.53	1.69	2.19	0.89
Simpson (1– <i>D</i>)	12.48	5.85	9.70	1.93
Evenness (<i>J</i>)	0.90	0.60	0.77	0.31

diversity of plant species and to restrictions of human activities in protected forests, favouring conditions for the development of insect fauna. On the other hand, Chichakli and Keleybar regions had the highest similarity based on the Sørensen's similarity index. Kandovan forest area had the highest species number and species diversity; its mixed cropping and grassland area provide food resources for insect prey growth on plants such as flowers and crops. Qurigol region had the lowest species diversity and species number, possibly due to poor vegetation and low plant species diversity in this wetland area covered by marshes.

Regarding biology of *Dolichopus* species, which are predators on small soft-bodied insects, it can be concluded that their population numbers are related to regional flora; so the greater the plant diversity, the larger and more diverse the insect prey and predator populations.

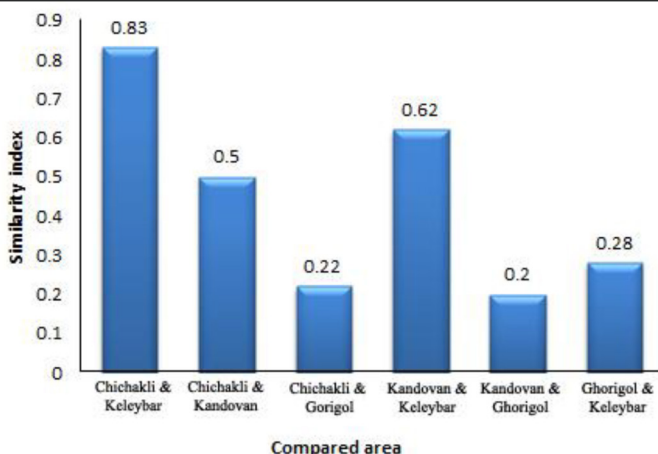


Fig. 7. Similarity indices for the genus *Dolichopus* in regions of East Azerbaijan Province, Iran.

Fig. 7. Índices de similitud para el género *Dolichopus* en las zonas de la provincia de Azerbaiyán Oriental, Irán.

Hutchinson (1959) found a positive correlation between plant food and species richness, suggesting that more numerous plant species potentially provide more niches for the development of animal species. Based on Sørensen's similarity index, the fauna of the Qurigol forestry area had the lowest similarity. Debinski & Holt (2000) noted that the very low compositional similarity of species between areas is probably due to habitat fragmentation that reduces area, changes ecological processes, and reduces connectivity.

Dolichopus longitarsis was the dominant species in the Chichakli, Keleybar and Kandoan regions, and *D. simplex* was the dominant species in Keleybar, Kandoan and Qurigol regions. It can therefore be concluded that these species dominate in East Azerbaijan province and *D. plumipes* dominates in Chichakli and Keleybar regions. We thus suggest that the latter species can be found more in forest areas. As *D. perversus* is the eudominant in Qurigol it can be supposed that this species occurs more in wetland area, though it was also found in a low frequency in forest areas.

This study aimed to survey aspects regarding the biodiversity of the genus *Dolichopus* in East Azerbaijan Province. As our results show high species diversity for the genus in this area, other dolichopodid genera merit research in the future.

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Annex 1. Number of collected specimens in May–August 2013 in regions of East Azerbaijan Province, Iran: N. Number of specimens; S. Sampling station; R. Region; Lt. Latitude; Ln. Longitude; A. Altitude.

Anexo 1. Número de especímenes recolectados en mayo–agosto de 2013 en las zonas de la provincia de Azerbaiyán Oriental, Irán: N. Número de especímenes; S. Estación de muestreo; R. Región; Lt. Latitud; Ln. Longitud; A. Altitud.

Species	N	S	R	Lt	Ln	A	Date
<i>Dolichopus austriacus</i>	5	3	Chichakli	38,619483	46,442667	1534	21/07/2013
<i>Dolichopus malekii</i>	6	3	Chichakli	38,619483	46,442667	1534	21/07/2013
<i>Dolichopus malekii</i>	5	5	Chichakli	38,617067	46,439267	1534	15/06/2013
<i>Dolichopus malekii</i>	6	6	Chichakli	39,654283	46,520583	2140	15/06/2013
<i>Dolichopus malekii</i>	5	9	Keleybar	38,859133	46,983450	1783	01/07/2013
<i>Dolichopus campestris</i>	5	4	Chichakli	38,507283	46,607450	1724	15/06/2013
<i>Dolichopus campestris</i>	5	8	Keleybar	38,851283	46,998867	1367	01/07/2013
<i>Dolichopus campestris</i>	3	14	Kandovan	37,737567	46,320933	3005	16/08/2013
<i>Dolichopus clavipes</i>	5	7	Chichakli	38,659100	46,279833	1059	12/07/2013
<i>Dolichopus clavipes</i>	5	9	Keleybar	38,859133	46,983450	1783	01/07/2013
<i>Dolichopus clavipes</i>	2	15	Kandovan	37,770517	46,250200	2341	20/08/2013
<i>Dolichopus griseipennis</i>	1	19	Qurighol	37,917133	46,687400	1847	22/08/2013
<i>Dolichopus immaculatus</i>	2	7	Chichakli	38,659100	46,279833	1059	12/07/2013
<i>Dolichopus kiritshenkoi</i>	6	16	Kandovan	37,750200	46,303900	2844	25/06/2013
<i>Dolichopus longitarsis</i>	7	3	Chichakli	38,619483	46,442667	1534	21/07/2013
<i>Dolichopus longitarsis</i>	5	6	Chichakli	39,654283	46,520583	2140	15/06/2013
<i>Dolichopus longitarsis</i>	8	11	Keleybar	38,848383	47,006117	1524	12/06/2013
<i>Dolichopus longitarsis</i>	11	16	Kandovan	37,750200	46,303900	2844	25/06/2013
<i>Dolichopus nubilus</i>	7	2	Chichakli	38,661167	46,281500	1112	29/05/2013
<i>Dolichopus perversus</i>	5	5	Chichakli	38,617067	46,439267	1534	15/06/2013
<i>Dolichopus perversus</i>	1	9	Keleybar	38,859133	46,983450	1783	01/07/2013
<i>Dolichopus perversus</i>	15	18	Qurighol	37,916250	46,685333	1943	27/06/2013
<i>Dolichopus plumipes</i>	3	1	Chichakli	38,569450	46,501517	1907	29/05/2013
<i>Dolichopus plumipes</i>	8	4	Chichakli	38,507283	46,607450	1724	15/06/2013
<i>Dolichopus plumipes</i>	5	8	Keleybar	38,851283	46,998867	1367	01/07/2013
<i>Dolichopus salictorum</i>	2	17	Qurighol	37,903850	46,703917	1921	06/07/2013
<i>Dolichopus siculus</i>	5	1	Chichakli	38,569450	46,501517	1907	29/05/2013
<i>Dolichopus siculus</i>	2	6	Chichakli	39,654283	46,520583	2140	15/06/2013
<i>Dolichopus siculus</i>	7	13	Keleybar	38,848383	47,006117	1524	10/07/2013
<i>Dolichopus signifier</i>	3	2	Chichakli	38,661167	46,281500	1112	29/05/2013
<i>Dolichopus signifier</i>	3	5	Chichakli	38,617067	46,439267	1534	15/06/2013
<i>Dolichopus signifier</i>	4	12	Keleybar	38,859133	46,983450	1783	26/05/2013
<i>Dolichopus signifier</i>	4	15	Kandovan	37,770517	46,250200	2341	20/08/2013
<i>Dolichopus simplex</i>	7	7	Chichakli	38,659100	46,279833	1059	12/07/2013

Annex 1. (Cont.)

Species	N	S	R	Lt	Ln	A	Date
<i>Dolichopus simplex</i>	8	10	Keleybar	38,851283	46,998867	1367	12/06/2013
<i>Dolichopus simplex</i>	7	16	Kandovan	37,750200	46,303900	2844	25/06/2013
<i>Dolichopus simplex</i>	4	17	Qurighol	37,903850	46,703917	1921	06/07/2013
<i>Dolichopus subpennatus</i>	7	6	Chichakli	39,654283	46,520583	2140	15/06/2013
<i>Dolichopus subpennatus</i>	3	8	Keleybar	38,851283	46,998867	1367	01/07/2013
<i>Dolichopus unguatus</i>	3	6	Chichakli	39,654283	46,520583	2140	15/06/2013
