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The subgenus *Arctotipula* Alexander in the genus *Tipula* Linnaeus (Diptera: Tipulidae) on Wrangel Island, Russia (Chukotka Autonomous Okrug)

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Abstract

Wrangel Island, Russia, because of its geographic position, harsh climate, yet surprising biodiversity, has been geobotanically studied and divided into various subzones. The distributions of the three species of the subgenus *Tipula* (*Arctotipula*) (Diptera: Tipulidae) that have been collected on Wrangel Island are related to these subzones. The predominantly Nearctic species, *T. (A.) besselsoides* Alexander, 1919, is newly recorded for Russia as well as on this island, where it was found to be the most widespread of the three species. The Holarctic species, *T. (A.) salicetorum* Siebke, 1870, is rarer, being found mostly in the climatically harsh northern and eastern areas of the island. The third species, *T. (A.) oklandi* Alexander, 1922, which was thought to have been more widespread formerly, is here confirmed only for Russia. It was collected in the warmest part of the island, and the female is illustrated for the first time. An illustrated key to both male and female adults is presented. Distribution maps are provided for all species, and the data on the distribution of *oklandi* have been adjusted.

Introduction

Wrangel Island, Russia, is part of the vast Beringian landmass that was not covered by ice during most of the Pleistocene. It lies at the border between the East Siberian and Chukchi seas and is a small mountainous island, with a maximum length of about 150 km, an area of about 7600 km², and both a varied landscape and a varied climate, which is clearly seen in the structure and composition of the plant communities between various parts of the island. Compared to similar islands in the Arctic, Wrangel Island has much richer fauna and flora (Stishov 2004; Khruleva *et al.* 2021, and references therein).

Most of Wrangel Island is in the Arctic tundra subzone (Figs. 1–4). The island's broad middle belt is the southern variant of the Arctic tundra subzone, and this is flanked by belts of the northern variant of the Arctic tundra subzone. There are small enclaves of warmer climate within the southern Arctic tundra subzone variant, and these are northern variants of typical tundra subzone. The cool, foggy northeastern and southwestern seacoasts have the harshest environment on the island, indicative of the southern section of the polar desert zone. These subdivisions of Wrangel Island are based on Kholod's (2013) geobotanical studies. This

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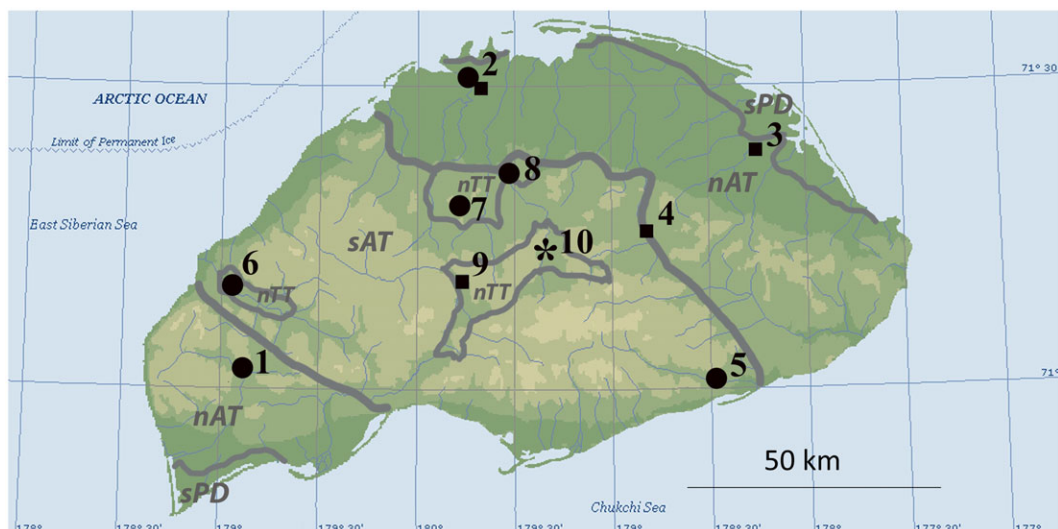


Fig. 1. Map of Wrangel Island, Russia, showing zonal differentiation of vegetation (based on Kholod 2013) and collection sites of *Arctotipula*: SPD, southern variant of polar desert zone; nAT, northern variant of Arctic tundra subzone; sAT, southern variant of Arctic tundra subzone; nTT, northern variant of typical tundra subzone. Bold grey lines mark the boundaries between various zones. Collection sites are marked by numbers: **1**, middle course of the Neozhidannaya River; **2**, low course of the Tundrovaya River; **3**, low course of Naskhok River; **4**, upper reaches of the Krasnyi Flag River; **5**, vicinity of Rogers Bay, low course of the Nasha River; **6**, low course of Goose (Gusinaya) River; **7**, near Tundrovaya Mountain; **8**, middle course of the Neizvestnaya River; **9**, middle course of the Mamontovaya River; and **10**, upper reaches of the Neizvestnaya River. Black circles, collection sites for *Tipula* (*Arctotipula*) *besseloides*; black asterisk, collection site for *T. (A.) oklandi*; black squares, collection sites for *T. (A.) salicetorum*.

division of subzones and the terminology used by Kholod (2013) have been criticised (Matveyeva 2014); however, this does not change the general picture. Note that the 180° longitude meridian runs through Wrangel Island, resulting in most of the collection points being registered as west longitude, but sites 1 and 6 in the western end of the island are registered as east longitude.

The Tipulidae (Diptera) of Wrangel Island are quite rich for an Arctic island and include at least 15 species, most of which belong to the genus *Tipula* Linnaeus (Khruleva 1987; Lantsov and Chernov 1987). Here, we contribute to knowledge of the fauna of Wrangel Island by adding information on the three species of the subgenus *Tipula* (*Arctotipula* Alexander) now known to occur on this island: *T. (A.) besseloides* Alexander, 1919, *T. (A.) oklandi* Alexander, 1922, and *T. (A.) salicetorum* Siebke, 1870. The female of *T. (A.) oklandi* is illustrated for the first time, and we present an illustrated key to the adults.

Material and methods

Specimens from the following institutions were studied for this project: Canadian National Collection of Insects, Ottawa, Canada (CNC; Bradley Sinclair) and Zoological Institute, St. Petersburg, Russia, (ZISP; Emilia Nartshuk). The global distribution maps for *T. (A.) besseloides*, *oklandi*, and *salicetorum* were based on specimens borrowed from 18 institutions in North America and Europe for further work on *Arctotipula* (Brodo and Lantsov, unpublished data).

Field collecting of Tipulidae was undertaken in various years during a survey of the entomofauna of Wrangel Island. In 1983–1994, material was collected by O.A. Khruleva by individual capture of specimens and by pitfall traps. In 2011, 2014–2016, and 2018–2019,



Fig. 2. Middle course of Neozhidannaya River, collection site 1, Wrangel Island, Russia. Photo taken by Khruleva in 2019.

yellow pan traps and sweeping were added; during this period, staff of the Wrangel Island Nature Reserve also took part in collecting. Over all these years, a total of more than 4000 adult specimens of Tipulidae were collected. *Arctotipula* species, however, were collected in only nine of 16 seasons, and only 45 specimens in total were collected. The more recent specimens, collected from 2011 to 2019, were preserved in 70% ethanol. Specimens collected earlier from 1983 to 1989 were placed between cotton layers. Subsequently, all specimens collected since 1983 were mounted on their side on paper points and pinned by Lantsov before being examined. Material from 2011 and 2015 was identified by V.I. Devyatkov, and the specimens are housed in the Institute of Systematics and Ecology of Animals, Siberian Branch of the Russian Academy of Sciences, Novosibirsk; all other material is in the collection of V.I. Lantsov.

Genital morphology was studied by clearing terminalia in potassium hydroxide solution (10%) and preserving them in glycerine, pinned below their respective specimen, in a microvial. Specimens studied by Brodo were further cleared in lactic acid after being submerged in potassium hydroxide solution and before being placed in glycerine: lactic acid neutralises any remaining potassium hydroxide and thus prevents the fading of specimens. Specimens were studied by Lantsov using an Altami microscope, and measurements were made using an MBS-10 microscope (Lytkarino Optical Glass Plant, Moscow, Russia) with a scale installed in the focal plane of the 8× eyepiece (division value of scale: 0.1 mm at 8× magnification). Photographs were taken by Lantsov with a Canon EOS 450D digital camera (Canon Inc., Ōta, Tokyo, Japan) and Sigma 17–70 mm F2.8–4.5 DC Macro (Sigma Corporation, Kanagawa, Japan) and TAMRON SP 70–3000 mm F/4–5.6 DI VC USD lenses (Tamron Co., Ltd., Saitama, Japan), connected with Rodenstock Rodagon 1:2.8 F = 50 mm lenses (Rodenstock



Fig. 3. Lower course of Nasha River, collection site 5, Wrangel Island, Russia. Photo taken by Khruleva in 2019.

GmbH, Munich, Germany). Brodo used a Wild M5 stereo microscope (Wild Heerbrugg AG, Gais, Switzerland), as well as a Zeiss Compound Microscope (Carl Zeiss AG, Oberkochen, Germany), and photographs were made with a Nikon Coolpix 4500 digital camera (Nikon, Minato, Tokyo, Japan) attached to the Wild M5. Photographs were subsequently modified for publication using Adobe Photoshop Elements 9 (Adobe, Inc., San Jose, California, United States of America), and plates were prepared using PowerPoint (MicroSoft, Redmond, Washington, United States of America). Photos of habitats and the map of Wrangel Island were made by Khruleva.

We use the terminology of morphological features presented by Cumming and Wood (2017).

Results and discussion

The subgenus *Tipula* (*Arctotipula*)

As its name implies, *Arctotipula* is mainly an Arctic and northern boreal subgenus, with some species occurring at high altitudes in mountainous regions (Savchenko 1961; Brodo 1990; Gelhaus *et al.* 2000; Oosterbroek *et al.* 2015). The subgenus is small, with 38 species and subspecies currently recognised. Of these, 14 are known from Russia (Oosterbroek 2022) and only four occur in the tundra zone (Lantsov and Chernov 1987). Species of the subgenus *Arctotipula* have been found in the mountainous countries of Central Asia (Tuva), Eastern Siberia, and Mongolia, but they have not yet been found in the mountains of Central Europe (Alps) and the Caucasus (Dufour 1986; Lantsov 2007). Two species with arcto-montane distributions were previously recorded from Wrangel Island: *T. (A.) oklandi* Alexander (Savchenko 1961, p. 325, as *T. (A.) ciliata*) and *T. (A.) salicetorum* Siebke (Khruleva 1987, p. 29; Lantsov and

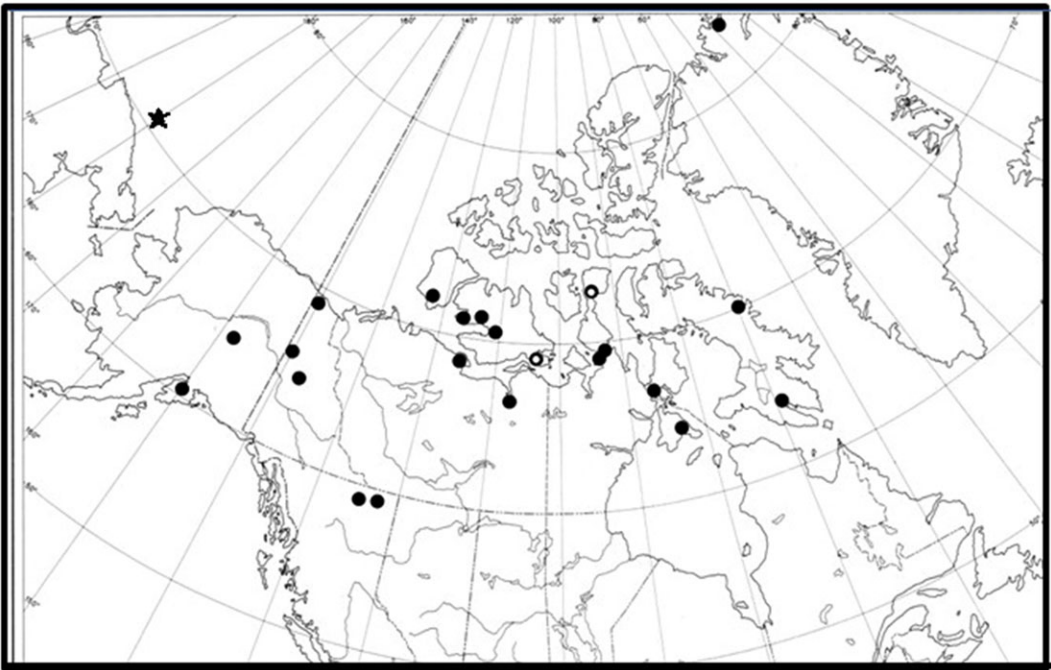


Fig. 4. Distribution of *Tipula (Arctotipula) besseloides*. Black star denotes Wrangel Island, Russia, collection site, closed black circles represent other collection sites for confirmed specimens, and open circles represent documented specimens not seen for this study.

Chernov 1987, p. 26). An entity listed as “*Tipula (Arctotipula) sp. (prope T. miyadai (Al.))*” was included by Khruleva (1987); the term “*prope*” is Latin for “near.” We have established here that this specimen belongs to *T. (A.) besseloides* Alexander, a newly recognised addition to the Wrangel Island fauna.

Adults of this subgenus can be recognised by their generally dark grey head and thorax, both covered with long dense setae, and dense setae on the coxae (Fig. 7A, B). Wings are unpatterned but lightly tinted and have a dark pterostigma that is enhanced by whitened areas on either side, and the calypters are glabrous. Antennae in both sexes are shorter than the thorax, and the scape is the longest segment and is densely covered with long setae; flagellomeres are almost cylindrical but slightly broadened at the attachment of the verticils (Fig. 7B). Males have the epandrium and hypandrium separated almost to the base. The epandrium is glabrous basally, and this section is usually obscured by the overlying eighth tergite, leaving only the densely setose distal section visible. The epandrium has a distal emargination, and the setae on either side and below this emargination are arranged in a characteristic pattern for *Arctotipula*, with their tips pointing towards the middle so that the lateral setae point towards the middle at a 45° angle (or less) and the central setae point caudally, with a gradual variation of slope in between (Figs. 7C, D; 9A; 10A, B). Ventrally, the hypandrium is divided shallowly or more deeply almost to its base; there are no lobes or other structures on either the hypandrium or on the eighth sternite. Females tend to be a few millimetres longer than their respective males but with abdomens in scale with that of the males. The female terminalia are reduced in length and narrower than the preceding segments.

Arctotipula larvae are also quite distinctive and easily separated from the larvae of other subgenera of *Tipula* by the five conical swellings on abdominal segments 2–7 – one on each venter and two in the pleural membrane on each side. The six lobes on the spiracular disk are

conical, covered with minute hairs or glabrous and with a small group of setae at the lobe tips. The spiracles are relatively small and spaced far apart. The fourth-instar larva of *T. (A.) salicetorum* was described by Hofsvang (1979) and Podeniene *et al.* (2006). The latter reference also included descriptions and beautiful illustrations of four other species of *Arctotipula* from Mongolia. Gelhaus (1986) described *T. (A.) sacra* Alexander from North America. The larvae of *T. (A.) besseloides* and *T. (A.) oklandi* are still to be discovered.

Arctotipula larvae are entirely aquatic (Pritchard and Hall 1971; Hofsvang 1979; Gelhaus 1986; Lantsov and Chernov 1987; Lantsov 1997), yet except for *T. (A.) conjuncta conjuncta* Alexander (Podeniene *et al.* 2006), they lack the long fringe of setae around the lobes of the spiracular disk that is usually associated with aquatic species such as *Angarotipula* Savchenko and *Prionocera* Loew (Brodo 2017). The fringe of setae on the flexible lobes of these latter two aquatic genera allows the lobes to fold together and trap an air bubble over the spiracles, thus allowing the larvae to breathe. The spiracular lobes of *Arctotipula* are stout and unable to fold together. Pritchard and Stewart (1982) showed that gas exchange occurs through the enlarged, thin-walled lobes on the spiracular disk, not through the spiracles, and suggested that the conical lobes on the abdominal segments may also be a source for oxygen uptake.

What we know about the *Arctotipula* larval life cycle is based on the excellent work by Pritchard and his colleagues (Pritchard and Hall 1971; Pritchard 1976; Pritchard and Stewart 1982) studying the immatures of *T. (A.) sacra* Alexander in the foothills of the Canadian Rocky Mountains, Kananaskis, Alberta, Canada. The black eggs are laid singly into the mud at pond edges or on floating mats of filamentous algae; each egg has a coiled filament that unfurls as an anchoring device. There are four instars, which is typical of other Tipulidae. Larvae usually overwinter for two years, first as a third-instar larva and a second winter as a fourth-instar larva (Pritchard and Hall 1971). When the fourth-instar larva is ready to pupate, it crawls out of the water and into the damp substrate on the shore (Pritchard and Hall 1971). These earlier findings suggest that *Arctotipula* species on Wrangel Island might need more than two years before pupation, given the harsh climate recorded for this island.

Fourth-instar larvae of *Arctotipula* are quite large, 28–42 mm long and about 4–8 mm wide (Gelhaus 1986; Podeniene *et al.* 2006). They live in shallow, highly oxygenated water and graze on the microflora in benthic sediments (Pritchard and Hall 1971). The content of the midgut and the anatomy of the digestive system of the fourth-instar larvae of *T. (A.) salicetorum* Siebke, from the Taymyr Peninsula, Russia, were studied by Lantsov and Chernov (1987). They found the remains of stonefly and chironomid larvae in the midgut. Predation was shown to be the dominant type of feeding in these specimens. In the Tuva ASSR, Russia, *T. (A.) salicetorum* was found in the highlands; the larvae develop along the edges of lakes and feed on detritus (Saaya 2021). Based on these findings, the biology of this subgenus has significant plasticity and probably varies within each species as well as in different parts of their ranges. Larvae and adults of crane flies, including the subgenus *Arctotipula*, make up a significant part of the trophic base of fish and semiaquatic insectivorous birds (Chernov 1985; Lantsov and Chernov 1987).

Distribution of *Arctotipula* species on Wrangel Island

The collection localities for the three species of *Arctotipula* are indicated by black numbers and symbols on the map of Wrangel Island (Fig. 1). More detailed and comparative information on the subzones, nature of the collection sites and their numbers, dates of collection, and the collectors for the recorded specimens are indicated in Table 1. The numbers of the collection sites in Table 1 correspond to the numbers in Fig. 1.

Tipula (Arctotipula) besseloides is newly recorded as occurring on Wrangel Island, even though it was the most abundantly collected of the three *Arctotipula* species on the island (Fig. 1). Adults were collected at six different localities, indicated by the black circles on the map (Fig. 1). The oldest specimen that we studied was a female from Rogers Bay (locality 5),

Table 1. Zonal position, localities, habitats, and collection dates of the three species of *Tipula* (*Arctotipula*) on Wrangel Island, Russia.

Zones	Location	Coordinates	Habitats	Dates	Collectors	Method	<i>T. (A.) besselooides</i>	<i>T. (A.) oklandi</i>	<i>T. (A.) salicetorum</i>
nAT	1	71° 2.52' N, 179° 8.91' E	Pebble floodplain, scattered deposits on wet sand, ~111 m. a. s. l.	9.vii.2019	OKh	Manual	3♂, 2♀		
	2	[71° 31' N, 179° 42.5' W]	Pebble floodplain with rare forbs.	25.vi–9.vii.1989	OKh	Pitfall traps			1♀, 1♂
			Sandy-pebble floodplain with moss–legume–dwarf willow cover	25.vi–9.vii.1989	OKh	Pitfall traps	2♂		
			River terrace with moss–legume–dwarf willow cover	25.vi–9.vii.1989	OKh	Pitfall traps	1♂		1♀
3	[71° 21' N, 178° 16' W]	Sandy-pebble floodplain	23.vii.1985	OKh	Manual			1♂	
n/s AT border	4	[71° 16.5' N, 178° 50' W]	River valley with mosses–dwarf willow	27.vii.1985	OKh	Manual			1♂
sAT	5	[70° 59' N, 178° 29' W]	No data	10.vii.1939	LP		1♀		
		71° 0.432' N, 178° 28.943' W	Pebble floodplain, silty sand sediments, isolated plants, ~83 m. a. s. l.	12.vii.1988	OKh	Manual	2♂		
				12.vii.2019	OKh	Manual	12♂, 9♀		
nTT	6	[71° 09' N, 178° 54' E]	Legume–dryad community on river terrace	28.vi–8.vii.1984	OKh	Pitfall traps	1♂		
	7	71° 17.863' N, 179° 47.875' W	Pebble floodplain, no vegetation, 133 m. a. s. l.	7–11.vii.2019	UB	Yellow pan trap	1♂		
	8	71° 20.287' N, 179° 29.779' W	River terrace with spotty legume–dryad community.	5.vii.1983	OKh	Manual	1♂		
			Pebble floodplain, isolated herb clumps, 46 m. a. s. l.	1.vii.1983	OKh	Manual	1♂		
				5–14.vii.2018	UB	Yellow pan trap	1♂		
	9	71° 09.585' N, 179° 45.595' W	Sandy-pebble floodplain with spotty willow–forb community, 151 m. a. s. l.	26.vi–19.vii.2011	AR	Pitfall traps			1♂, 1♀
	10	71° 12.838' N, 179° 19.276' W	Low pebbly floodplain, silt deposits, scattered plants, 115 m. a. s. l.	26.vi–6.vii.2015	OKh	Pitfall traps		1♂	
			Sedge–forb tundra–steppe community on S facing dry rubble–loamy edge of river terrace, 121 m a s l.	21.vi.2015	OKh	Sweeping		1♂	
				23.vi–5.vii.2015	OKh	Pitfall traps		1♂	

Zonal variants: nAT, northern variant of Arctic tundra subzone; sAT, southern variant of Arctic tundra subzone; nTT, northern variant of typical tundra subzone. Locality refers to the numbered collection sites (Fig. 1). Approximated coordinates are given in square brackets. a. s. l., above sea level; Collectors: OKh – O.A. Khruleva; UB – U.V. Babiy; LP – L.A. Potenko; AR – A.A. Rodionov.

collected on 10 July 1939 by Portenko (ZISP). We think that this is the same female specimen referred to as *T. (A.) ciliata* Lundstrom by Savchenko (1961, p. 327). No identification label was placed with this specimen. The other 36 specimens were collected in the island's vast river valleys, mainly on pebble and sandy-pebble floodplains, with or without clumps of vegetation. From 1983 to 1989, eight adults were collected in all zonal variants except in the harshest climate in the polar desert zone. In the northern variant of the typical tundra subzone, represented on the island by three isolated enclaves (Fig. 1), the species was collected in locality 6 in the west and in locality 8 in the north but not in the warmest enclave in the centre of the island, despite the fact that research was conducted there for four seasons, from 1991 to 1994. In the current century, this species was rediscovered in localities 8 (2018) and 5 (2019), and it was additionally found in two more areas that had not been studied before (localities 1 and 7). The majority of adults were collected in 2019 during a special survey of *Arctotipula* habitats in river valleys. Two large series were collected in different variants of the Arctic tundra subzone: the northern (Neozhidannaya River, (Fig. 2), southwestern part of the island; locality 1) and the southern (Nasha River (Fig. 3), southeastern part of the island; locality 5). Thus, *T. (A.) besseloides* is widely distributed on Wrangel Island; however, not counting 2019, it was mainly collected as singletons. Wrangel Island is the only Russian locality for this species, but it has been collected in considerable numbers in the Arctic regions of North America and in Greenland (Fig. 4; Brodo 1990; Oosterbroek *et al.* 2007, 2015).

Tipula (Arctotipula) oklandi was found in 2015 in the enclave of the typical tundra subzone located in the warmest central part of Wrangel Island, locality number 10 (black asterisk, Fig. 1). It was collected in two habitats (pebble floodplain and at the edge of a high river terrace with a tundra-steppe-like sedge-forb community) about 300–400 m apart from each other along the river valley. The specimens were identified by V.I. Devjatkov.

A female identified as *T. (A.) ciliata* Savchenko (= *oklandi*) collected at Rogers Bay (locality 5) on 10 July 1939 by Portenko (Savchenko 1961, p. 327; Lantsov and Chernov 1987, p. 26) is here identified as *T. (A.) besseloides* and was mentioned above. An earlier record of this species from Wrangel Island is erroneous, but new material confirms its presence here. It is the rarest of the three species and has been collected elsewhere in Russia only on Novaya Zemlya, Taymyr Peninsula, in the Sakha Republic (near Verkhoyansk) and on the Northern Kurile Island of Paramushir, in Sakhalin Oblast (Savchenko 1961; Lantsov and Chernov 1987; Fig. 5). It was mistakenly recorded from North America under the incorrect assumption that *T. (A.) alascaensis* Alexander is a synonym of *T. (A.) oklandi* (Brodo and Lantsov, unpublished data). Specimens cited by Savchenko (1961) from the tundra of Eastern Siberia (Kotelny Island, the lower reaches of the Yana and Indigirka rivers) have been found to belong to other species (Brodo and Lantsov, unpublished data) and so are not shown on the present study's map. Currently, Wrangel Island is the northeasternmost point of detection of this species.

Tipula (Arctotipula) salicetorum is also rare on Wrangel Island. It was collected in 1985 and 1989 at three sites in the northern and eastern parts of the island, in the northern variant of the Arctic tundra subzone, a region with a harsh climate. More recently, it was found only once in the northern enclave of the typical tundra subzone (Mamontovaya River, locality 9; see black squares, Fig. 1). Specimens were collected on substrates similar to those the other two species were collected on. *Tipula (A.) salicetorum* has the most widespread distribution of the three species, extending across Sweden, Norway, Finland, scattered localities in northern Russia, and across subarctic North America from Alaska to Quebec (Fig. 6). It was not found in Greenland (Oosterbroek *et al.* 2007, 2015).

The composition of the *Arctotipula* species on Wrangel Island is a vivid example of the role of the geographical location of this island. Here, we find a species with a wide Holarctic distribution (*Tipula (A.) salicetorum*), a species for which Wrangel Island is the extreme easternmost locality (*T. (A.) oklandi*), and a species for which Wrangel Island is the

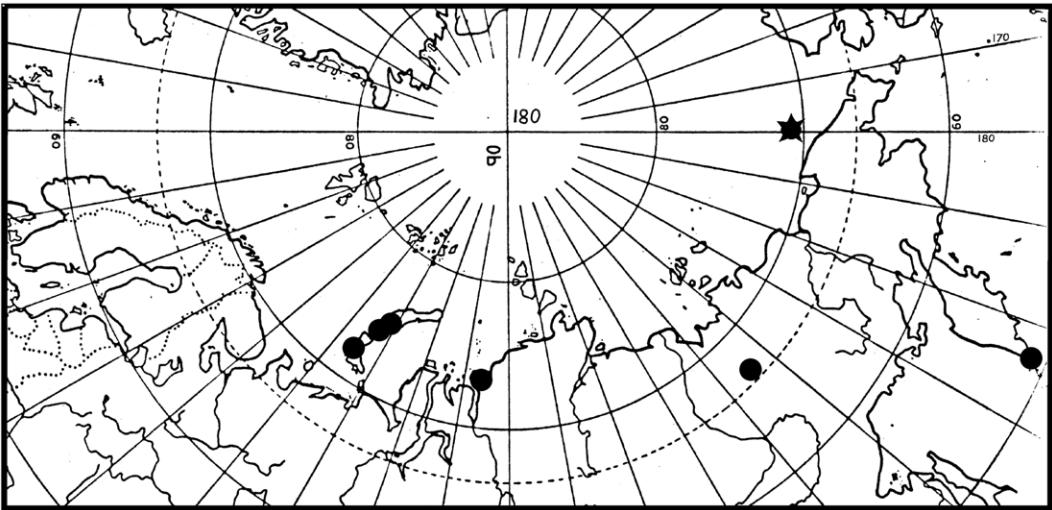


Fig. 5. Known distribution of *Tipula (Arctotipula) oklandi*. Wrangel Island, Russia, is denoted by a black star.

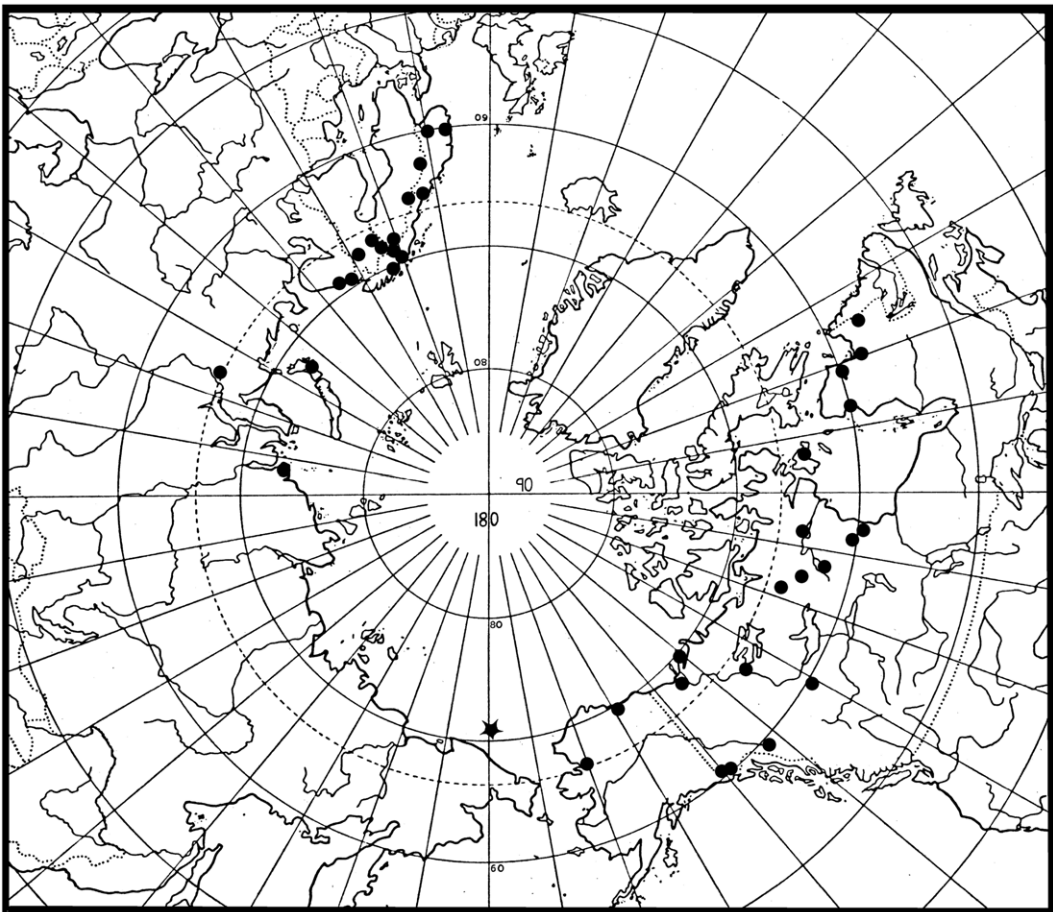


Fig. 6. Known distribution of *Tipula (Arctotipula) salicetorum*. Wrangel Island, Russia, is denoted by a black star.

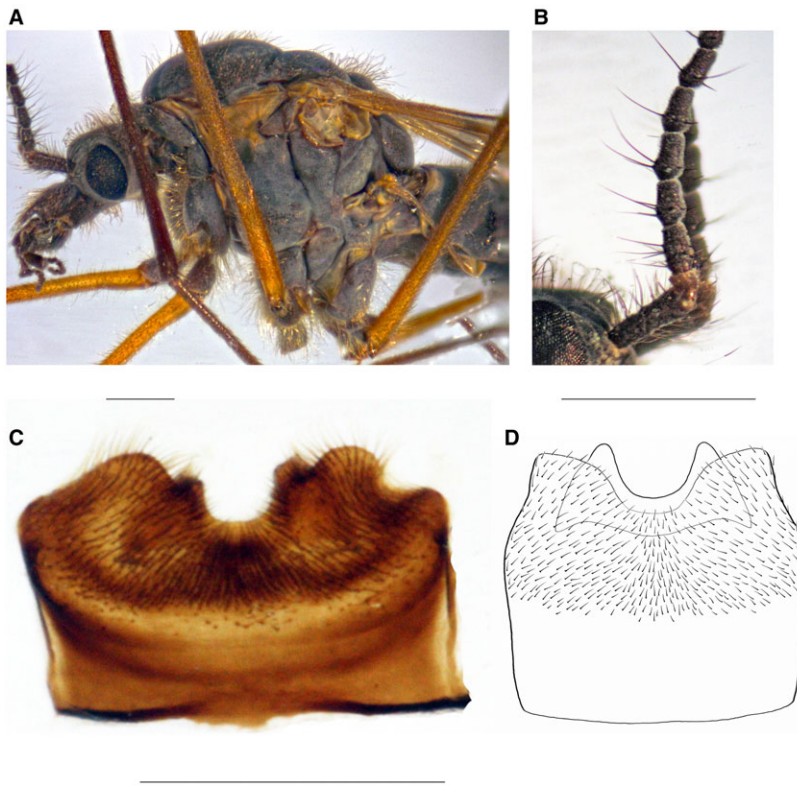


Fig. 7. Male *Tipula* (*Arctotipula*) *besseloides*: **A**, showing dense brown setae on head and thorax; **B**, antennae showing long setose scape and position and relative length of verticils on flagellar segments; **C**, epandrium showing rounded distal emargination and protruding ventral sclerite; **D**, epandrium depicting arrangement of setae on distal section. Scale bars: 1 mm.

westernmost locality (*T. (A.) besseloides*). That the latter species is the most numerous and widespread on the island is quite unexpected.

The presence of species with a predominantly North American distribution is one of the features of the island's biota. Among Diptera, examples are known from the families Agromyzidae (Nartshuk and Khruleva 2011, 2018), Muscidae (Sorokina and Khruleva 2012; Sorokina and Tridrikh 2021), Syrphidae (Barkalov and Khruleva 2021), Empididae (Khruleva *et al.* 2021), and Hybotidae (Khruleva *et al.* 2021). Since 2000, the species from the families Agromyzidae, Empididae, and Hybotidae are most numerous in the warmest central enclave of the northern variant of the typical tundra subzone, whereas *Tipula besseloides* has never been found there.

Tipulid collections on Wrangel Island were made in seasons with different weather conditions. The last years of research fell during the period of warming of the Arctic climate, which began in the 2000s. Unlike the always-numerous mesophilic species *Tipula (Pterelachisus) carinifrons carinifrons* Holmgren, 1883, and *Tipula (Vestiplex) wrangeliana* Stackelberg, 1944 (Khruleva 1987 and unpublished data), species of the subgenus *Arctotipula* were rare in collections throughout the entire period of research. The data obtained do not allow us to talk about a noticeable increase in their numbers in a changing climate, although in recent years, a rapid increase in the number of some other groups of Diptera has occurred on Wrangel Island (Khruleva and Zinchenko 2017; Grichanov and Khruleva 2018, 2020; Nartshuk and Khruleva 2018).

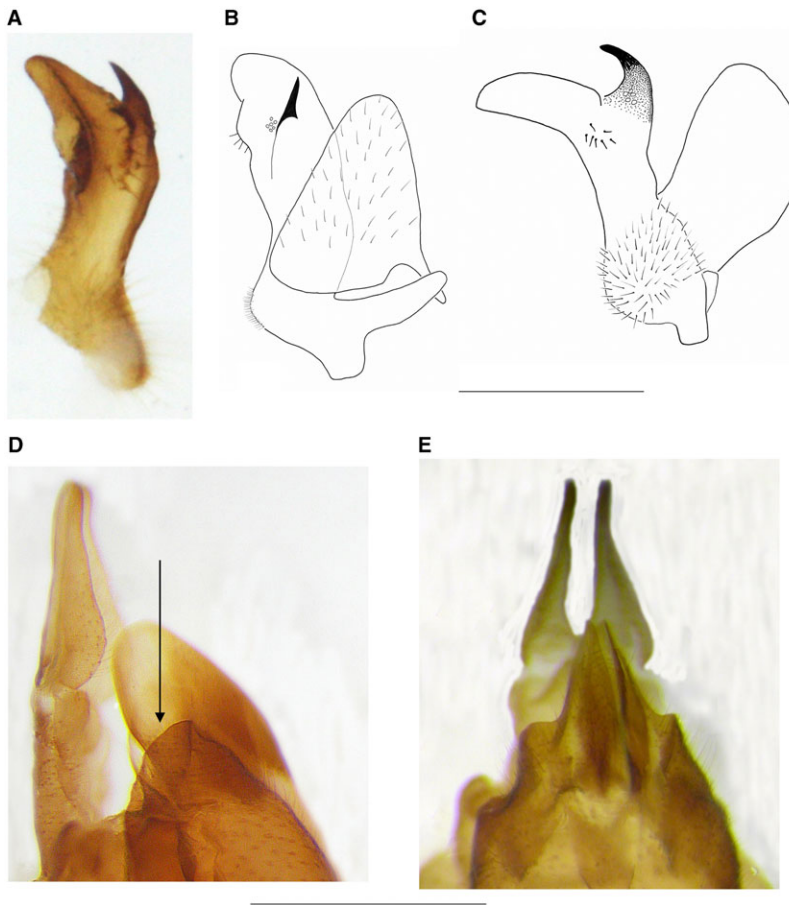


Fig. 8. *Tipula (Arctotipula) besseloides*: **A**, male, right gonostylus, ventro-medial view; **B**, male, inner and outer gonostyli, ventral view; **C**, male, inner and outer gonostyli, medial view; **D**, female terminalia, lateral view; **E**, female terminalia, ventral view. Scale bars: A–C, 0.5 mm; D–E, 1 mm. Arrow pointing to rounded shoulder of eighth sternite.

Key to the adults of *Tipula (Arctotipula)* known from Wrangel Island

1. Conspicuous setae on head and thorax (Fig. 7A, B); wings tinted, unpatterned, distal wing veins glabrous or with scattered, difficult-to-see macrotrichia; antennae with relatively long setose scape, flagellomeres with longest verticils longer than respective segments (Fig. 7B). Males: epandrium glabrous basally, densely setose distally with setae arranged in a characteristic pattern with tips pointing towards the middle (Fig. 7C, D). Females with relatively short and narrower terminalia, with ninth tergite wrapping around base of tenth tergite; cerci weakly to moderately sclerotised; eighth sternite with lateral extensions ***Tipula (Arctotipula) 2***
- . Thoracic setae generally short, not particularly obvious; wings variable, often patterned and usually with conspicuous setae on distal wing veins; antennae variable. Male: epandrium usually with short, scattered setae over the entire surface, setae generally with tips pointing caudally. Female terminalia if reduced, ninth tergite not wrapping around base of tenth tergite; cercus and hypogynial valves generally longer and more heavily sclerotised **other subgenera of *Tipula***

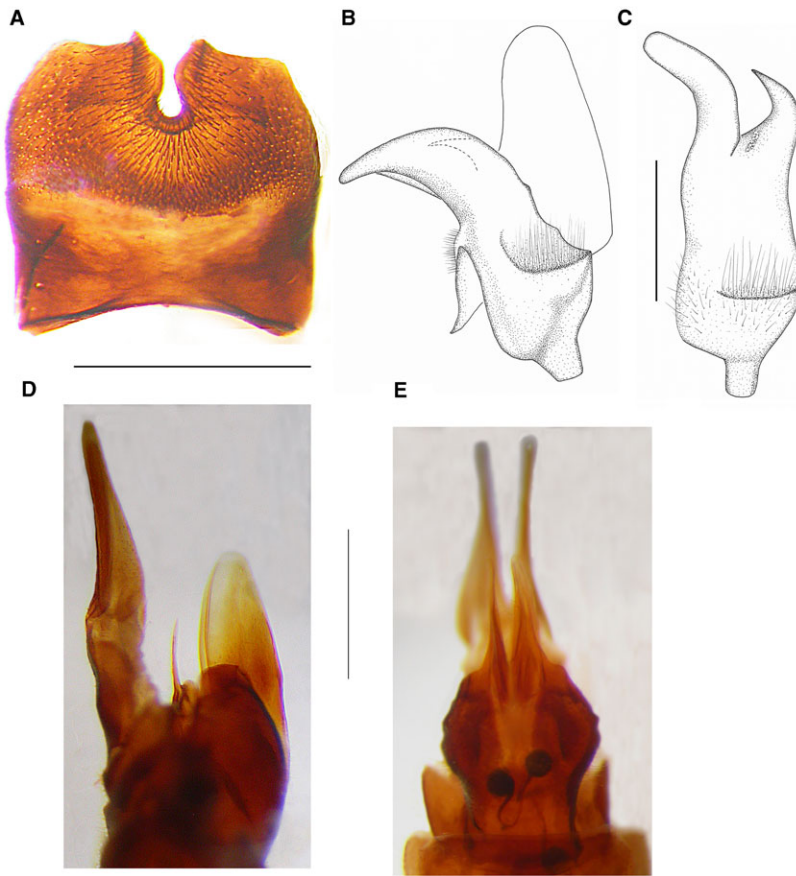


Fig. 9. *Tipula (Arctotipula) oklandi*: **A**, male epandrium; **B**, male right inner and outer gonostyli, medial view; **C**, male right inner gonostylus, ventral view; **D**, female terminalia, lateral view showing cercus longer than tenth tergite, smoothly and narrowly broader at base, hypogynial valve elongate, slender, truncately rounded lobe on eighth sternite; **E**, female terminalia, ventral view, broader and irregular contour of eighth sternite. Scale bars: **A**, 1 mm; **B** and **C**, 0.5 mm; **D** and **E**, 1 mm.

2. White setae on head and thorax. Male epandrium with short truncate distal lobes, somewhat attenuated distolaterally, lobes separated medially by squarish gap, with blackened toothed bar beneath, usually visible in gap (Fig. 10A, B); inner gonostylus with narrow distal portion bent at right angles to broader base, with triangular blackened patch medially (Fig. 10C). Female with reduced terminalia, cerci pale, unsclerotised, and usually folded over hypogynial valves in pinned specimens, broad lobes on eighth sternite obscuring much of the terminalia laterally (Fig. 10D)..... *salicetorum* Siebke
- . Brown setae on head and thorax. Male epandrium with rigid rounded or narrow distal emargination, with pale ventral sclerite behind distal lobes; inner gonostylus with sharply pointed blackened hook behind or lateral to distal beak. Female with sclerotised cerci usually horizontally aligned, hypogynial valves quite visible..... **3**
3. Male epandrium with circular medial emargination between short distal lobes (Fig. 7C, D); inner gonostylus with subrectangular distal beak (medial view), with prominent sharply pointed hook behind and with flattish cushion of setae medially at base (Fig. 8A–C). Female with cerci subequal to tenth tergite, roundly expanded near base; rounded shoulder on eighth sternite; hypogynial valves relatively short and broad, length from tip to rounded

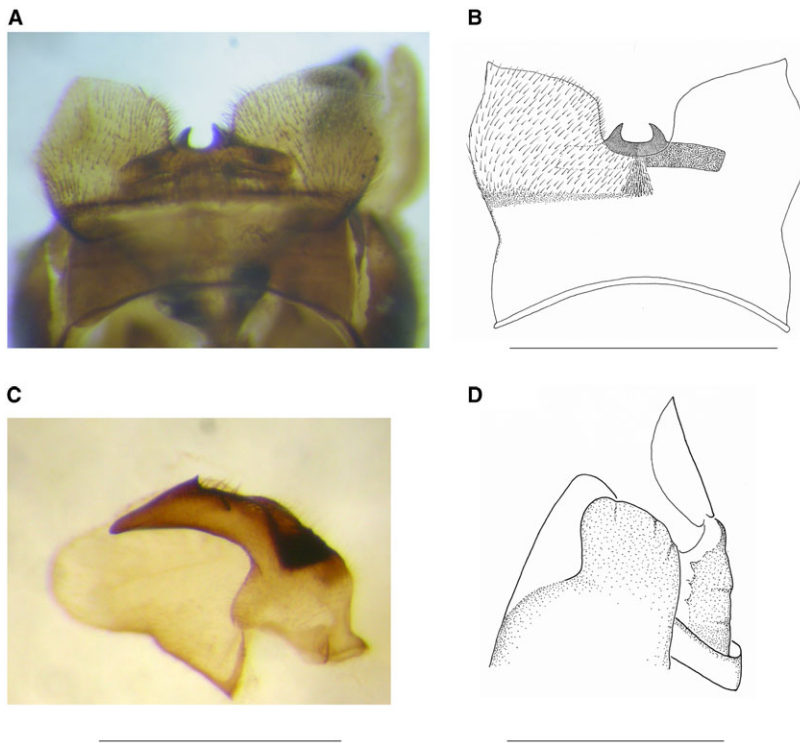


Fig. 10. *Tipula (Arctotipula) salicetorum*: **A**, male epandrium showing toothed bar behind distal lobes; **B**, male epandrium showing characteristic setal pattern and position of toothed bar beneath lobes; **C**, right inner and outer gonostyli, medial view; **D**, female lateral aspect, lobe of eighth sternite obscuring hypogynial valve. Scale bars: **A**, **B**, and **D**, 1 mm; **C**, 0.5 mm.

shoulder subequal to width at base (Fig. 8D); ventrally, shoulder appears perpendicular to valves, usually with second, step-like shoulder below (Fig. 8E)..... *besselsoides* **Alexander**
 -. Male epandrium with deep, narrow, reinforced slit medially (Fig. 9A). Inner gonostylus with broadly triangular distal beak in medial aspect, obscuring smaller sharply pointed hook that sits lateral to, rather than behind, distal beak; protruding flat-topped extension at base densely covered with long setae with many shorter setae between (Fig. 9B, C). Female with cerci somewhat longer than tenth tergite, smoothly and narrowly broadening towards base; projecting shoulder on eighth sternite with almost horizontal distal edge; hypogynial valves elongate, length from tip to rounded shoulder longer than width at base (Fig. 9D); ventrally eighth sternite broader medially with irregular profile (Fig. 9E)..... *oklandi* **Alexander**

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