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Why do Tipulomorpha (Diptera, Insecta) succeed in the arctic conditions?

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Abstract. Adaptations of Tipulomorpha, adults and larvae, to arctic tundra conditions are discussed.

Key words: adaptation, arctic, tundra, Tipulomorpha, crane flies.

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Tipulomorphic dipterans are one of the most important group of the arctic entomofauna. In the Arctic they are represented comparatively better than other taxons of Diptera (LANTSOV, CHERNOV 1987). In the tundra zone the Tipulomorpha have the representatives in all main taxonomic groups of the superfamily level: Trichoceroidea, Tipuloidea, Chironomoidea, Culicoidea, Psychodoidea. This is best illustrated by the mode of penetration of Tipulomorpha in the highest latitudes of the tundra. So in the polar desert communities they take absolutely dominant position not only among Diptera but also among insects as a whole. Chironomidae are dispersed in the polar desert especially (CHERNOV et al. 1977; DANKS 1980, 1981) (table 1). The mode of representation of the main genera of Tipulidae in the tundra zone is interesting. From 16 subgenera of the genus *Tipula* which are represented in Palaearctic (SAVTCHENKO 1983) - 12 subgenera and 40 species are in the tundra zone and 6 subgenera are in the arctic tundra subzone. Three typical arctic crane-flies: *Tipula carinifrons* HOLM., *T. lionota* HOLM., *T. glaucocinerea* LUNDSTR. - belong to different subgenera: *Pterelachisus, Yamatotipula, Savtshenkia* accordingly. Several subgenera (*Pterelachisus, Savtshenkia, Vestiplex*) are represented in the tundra zone and in the arctic tundra subzone by a comparatively larger number of species.

This fact makes a good illustration of a considerable predisposition of the genus to the existence in the arctic conditions. The families of Tipulomorpha demonstrate different patterns of distribution in the arctic landscape. Chironomidae are distributed around the

Table I

Mode of representation (number of species) of *Tipula* in the tundra zone (according to SAVTCHENKO 1983; LANTSOV, CHERNOV 1987).

Subgenus	Palaearctic (in all)	Palaearctic (boreal fauna)	Tundra zone (in all)	Arctic tundra subzone
Pterelachisus ROND.	56	23	7	5
Savtshenkia MNNHS.	37	27	6	3
Vestiplex BEZZI	70	13	7	4
Arcotipula AL.	12	8	4	3
Oreomyza POK.	35	12	3	1
Yamatotipula MATS.	49	18	4	1
Platytipula MATS.	35	4	1	–
Lunatipula EDW.	167	37	2	–
Lindnerina MNNHS.	4	4	1	–
Angarotipula SAV.	4	2	1	–
Odonatisca SAV.	5	3	2	–
Beringotipula SAV.	1	1	1	–

entire arctic territory, including the polar desert. Limoniidae inhabit mainly the south tundra and to a lesser degree - typical tundra and the arctic tundra subzone. Trichoceridae and Tipulidae are well represented within the boundaries of the entire tundra including the arctic tundra subzone, penetrate to the polar desert and have a number of typical arctic species.

In general Tipulomorpha display in the arctic conditions all main features of biological progress: a relative diversity of species, wide adaptative radiation, abundance, the diversity of interactions in tundra communities, a significant role in the arctic ecosystems. The representatives of Tilpulidae and Chironomidae inhabit in mass all kinds of the tundra's landscape biotopes: from strictly zonal to submarines and from the warmest to nival ones. The wide adaptive radiation of crane-flies larvae is rather characteristic - for instance among Tipulidae one can pick out mesophillous (*T. carinifrons*), *hygrophilous* (*T. glaucocinerea*) and *hydrophilous* species (*Arctotipula* subgenus and genus *Prionocera*). Chironomidae in the arctic tundra and polar desert and Tipulidae in the arctic tundra - are among the main dominants of animal population - they rank high by biomass indices in particular (CHERNOV 1978). The abundance of tipulid larvae and their biomass in the zonal tundra communities is larger than the same indices in deciduous forest: up to 150 spec/m and 13.8 g/m in dry biotopes and up to 350 spec/m and 34 g/m in wet ones. The number of chironomid larvae in the bare spots of the polar desert is up to 2000 spec/m (CHERNOV et al. 1977).

Significant is the trophocenotic role of Tipulomorpha in the tundra and polar desert communities. Larvae and adults of Tipulidae, Chironomidae and Limoniidae make the trophic base of a lot of carnivorous birds and fishes and are the essential component of detritus trophic chains. They also play a great role in the proceses of destruction and some of them - in flowers pollination (CHERNOV 1967; LANTSOV, CHERNOV 1987).

The biological progress of Tipulomorpha in the Arctic is linked up with their general evolutionary primitivity. As it was shown previously by the examples of many groups of plants and animals (CHERNOV 1984, 1988), the lower phylogenetic level of the group is, the more adaptable it becomes in the extremal conditions of the Far North.

Tipulomorpha possess a number of plesiomorphic features: low degree of oligomerisation (elongate cylindrical abdomen with homonomous segments), small costalisation of a wing, primitive morphology of larvae, relict character of some families, in particular Trichoceridae (RODENDORF 1964) which is well represented in the Arctic region. The ecolological features are: imperfection of flight, general hydrophily, lesser diversity of behavioral patterns, absence of deep trophic specialisation, including trophic relations with certain groups of higher plants etc. Great antiquity of the group is undoubtedly an indirect confirmaton of its primitiveness. The last one is connected with great biological plasticity (lability) of life cycles, which is in particular well illustrated by its considerable extension up to 5 or even 7-8 years in Tipulidae, Limoniidae, Chironomidae (CHERNOV, SAVTCHENKO 1965; MACLEAN 1973, 1975; BUTLER 1982; LANTSOV 1982a, 1982b). The ecobiological peculiarities which can be mentioned as prerequisites for adaptation of Tipulomorpha to the tundra environments are the lability of larvae food regimens (polytrophy of larvae), general primary hydrophily of the group which faciliates successful existence in land conditons with constant superfluous moistening.

The preadaptive mode of adaptations of Tipulomorpha to the Far North environment is undoubted. A large number of biological features of the arctic species are inherent not only in the last ones, but also in some southern species, or in general are characteristic to the family as a whole. In the arctic conditions the nothern species share the complex of adaptive features of the group which are useful in high latitudes: general hydrophily, low temperature of physiological activity, polytrophy of larvae, capability to survive low temperature, long duration of larvae and some others.

We have offered (LANTSOV, CHERNOV 1987) the classification of adaptive features of the arctic species of Tipulomorpha.

Conventionally the adaptations of arctic Tipulomorpha can be divided into the so-called "active" and "passive" ones, which are more characteristic to primitive taxons. More general and typical adaptations of arctic Tipulomorpha belong to the category of the "passive" ones. It is conceived that the Tipulomorpha as the more primitive and ancient group is characterised (to a much greater degree than higher dipterans) by "passive" patterns of adaptive strategies, caused by the labile (submissive) modes of organism's reaction to unfavourable influence of the environment. So these peculiarities in a great degree promote Tipulomorpha to adapt well in the mostly high latitude variants of the arctic landscape.

Table II.

Adaptive peculiarities of Tipulomorpha (particularly tipuloid crane-flies) in the arctic tundra environments (according to LANTSOV, CHERNOV 1987).

I. Morphological.
1. Shortening of wings (brachypterism).
2. Body size reduction.
3. Enhanced body pigmentation (melanism).
4. Shortening of legs.
5. Enhanced body clothing (pilosity).
II. Ecophysiological.
"Passive"
1. Perennial development of larvae.
2. Lability of life cycle, absence of strictly seasonal localisation of preimaginal stages.
3. Facultative diapause.
4. Decreasing of fecundity.
5. Increasing of larvae polytrophy.
6. Additional hibernation of a part of IV stages larvae, ready for pupation (in favourable temperature) - creation of population's reserve.
7. Simplification of reproductive behaviour, facultative patterns of swarming.
"Active"
1. Rapid completion of imago reproductive functions.
2. Acceleration of pupa stage and simultaneous emergence of imago, when the temperatures arise up to the threshold level.
3. Development of larvae phytophagy and carnivorism.
4. Increasing of imago trophic activity.
III. Ecological
1. Oviposition in well warmed places.
2. Coupling of Trichoceridae in lemmings burrows and use of other shelters from wind.
3. Maximal usage of the sun radiation - localisation of larvae in the upper layers of grassy turf.
4. Tendency to the herpetobiotic habits of life.
5. Changes of microbiotopical localisation of tipulid and trichocerid larvae during life cycle.

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