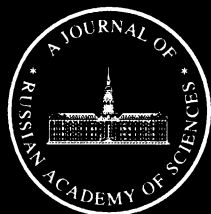


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# Correlated Northward Distribution of Macrolepidopterans and Their Food Plants along the Ural Mountains

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**Abstract**—Lists of macrolepidopterans inhabiting the Southern, Middle, and Polar Urals have been used for analyzing the relationship between the species richness of these insects with that of the families of plants on which their larvae feed. The results have shown that this factor in the Southern Urals accounts for approximately 75% and 65% of variation in the species richness of lepidopterans on woody and herbaceous plants, respectively. In the Polar Urals, this correlation is markedly weaker. Latitudinal trends in trophic preferences of individual lepidopteran taxa have been revealed. Probable causes of changes in the relative abundance of lepidopterans north of the forest zone are discussed.

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**Key words:** lepidopterans, higher plants, northward distribution, species richness, trophic changes.

In our previous study (Bogacheva et al., 2003), we made an attempt to reveal the role of food quality in the possibility of expansion of lepidopterans to the north, from the southern boundary of the forest zone to low latitudes of the Arctic, considering food resources (primarily plants) from the standpoint of their nutrient value. Quantitative parameters are also important for characterizing vegetation as food for phytophagous animals. They may be among the main factors determining the possibility of insect expansion to high latitudes, as shown by certain examples discussed previously (Bogacheva, 1997b).

The quantitative aspects of food resources as a factor conditioning the species richness of taxonomic or ecological groups of phyllophages has been discussed since the late 1970s, mainly in foreign publications. Their authors compared large and small genera and families of host plants (Neuvonen and Niemelä, 1981; Niemelä and Neuvonen, 1983; Godfray, 1984) and plants differing in the size of their ranges (Lawton and Schroder, 1977; May, 1979; Neuvonen and Niemelä, 1981; Niemelä et al., 1982; Niemelä and Neuvonen, 1983; Leather, 1986), abundance (Neuvonen and Niemelä, 1981; Niemelä and Neuvonen, 1983; Leather, 1986, 1991), and the period of life in a given area (Southwood, 1961; Birks, 1980; Blaustein et al., 1983). In any case, it was regularly observed that more apparent food resources attracted more complicated communities of their consumers and were utilized more completely.

We decided to find out whether these ideas are applicable to the feeding of lepidopterans in the forest zone,

from its southern to northern boundaries, choosing as a test parameter the species richness of these insects (Macrolepidoptera) associated with plants of different families. This analysis was based on the lists of lepidopterans for the Southern, Middle, and Polar Urals (Bogacheva et al., 2003) and the lists of corresponding floras.

## MATERIAL AND METHODS

In the Southern Urals, lepidopterans were collected in the Il'men State Nature Reserve (55° N). Complete lists of their species for the corresponding area were recently published (Olschwang et al., 2004). In the Middle Urals, the Heterocera were collected by G.A. Zamshina at the Biological Station of the Ural State University (56°30' N), and the results have not yet been published; data on the Rhopalocera were taken from the book by Korshunov and Gorbunov (1995). In the Polar Urals (66–67° N), lepidopterans were collected by many researchers in different years, and the results were published only partly (Olschwang, 1980; Gorbunov and Olschwang, 1993; Korshunov and Gorbunov, 1995). More detailed data on the sources of information for compiling the initial species lists and the methods for collecting lepidopterans are available from our previous paper (Bogacheva et al., 2003).

The taxonomy of lepidopterans in this paper follows that in the book *The Lepidoptera of Europe: A Distributional Checklist* (1996). Information on plants on which these insects feed was taken from published sources (Hofmann, 1897; Lampert, 1913; Zolota-

renko, 1970; Merzheevskaya et al., 1976; Koch, 1984; Derzhavets et al., 1986; Korshunov and Gorbunov, 1995).

All species of lepidopterans associated with gymnosperms and angiosperms were divided into two groups, specialists and generalists. A species was considered a specialist if it fed only on plants of one family and a generalist in all other cases (Bogacheva et al., 2003). The only exception was made for species feeding on graminoids (grasses, sedges, and rushes) because of insufficiency of data on their particular food plants and considerable similarity between these plant families with respect to chemical composition. We regarded the species that fed only on these plants as specialists, and the species that had additional food resources (other than graminoids) as generalists.

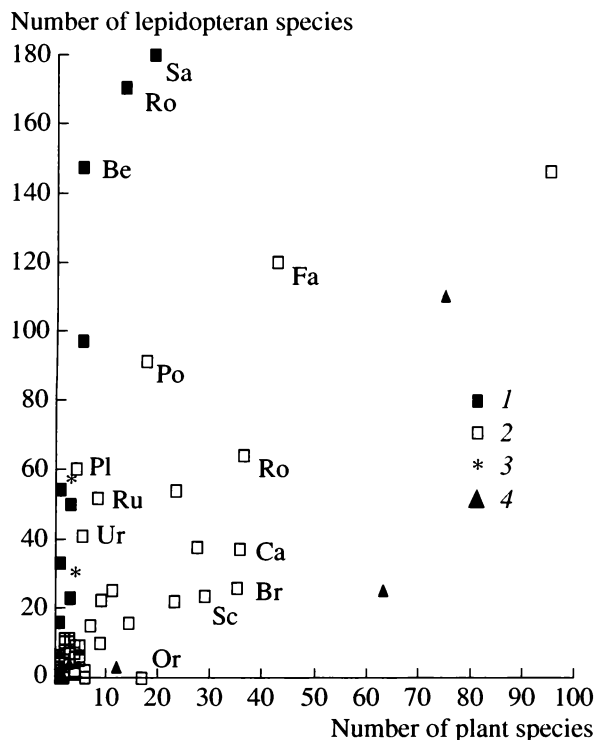
We used published lists of plant species for the Il'men State Nature Reserve (Dorogostaiskaya, 1961) and the Biological Station of the Ural State University (*Flora and rastitel'nost'*..., 2003). As to data on the Polar Urals, lepidopterans were collected there in a large area covering the Polar Ural Mountains themselves, their foothills, the city of Labytnangi, and the adjoining Ob floodplain. There was no publication comprising floristic lists for all these localities. Hence, we compiled such a list on the basis of relevant papers (Igoshina, 1961, 1966; Trotsenko, 1974) and the herbarium of the Ecological Research Station of the Institute of Plant and Animal Ecology, where collections from these localities were stored. In all cases, plant taxonomy corresponded to that in the identification key for vascular plants of the Middle Urals (*Opredelitel'*..., 1994). Aquatic plants, which do not serve as food for macrolepidopterans, were excluded from analysis.

The significance of differences discussed below was determined by Pearson's  $\chi^2$  test (Hudson, 1970). Correlation coefficients were calculated using the QuattroPro program.

## RESULTS

**Distribution of lepidopterans by plant families in the Southern Urals.** The vegetation of the Southern Urals is utilized by lepidopterans fairly thoroughly: these insects were found on plants representing 78.2% of families comprising the local flora. The relationship between lepidopteran species richness and plants proved to be relatively weak: the coefficient of correlation between the number of plant species in the family and the number of lepidopteran species feeding on the plants of this family was only  $r = 0.34$ .

As follows from Fig. 1, however, the diagram describing this relationship contains two distinct groups of points corresponding to woody and herbaceous plants, and a significantly greater number of lepidopterans are associated with the former than with the latter. Attempts have been made to explain this difference from the standpoint of food resource apparency,



**Fig. 1.** Correlation between the numbers of plant species in families of the Southern Ural flora and the numbers of lepidopteran species associated with plants of these families: (1) deciduous woody plants, (2) dicotyledonous herbaceous plants, (3) evergreen woody plants, (4) graminoids. Families mentioned in the text are designated by the first letters of their Latin names.

with regard to parameters such as plant diversity and abundance; individual size; architectural complexity, which is higher in woody plants; etc. (Niemelä et al., 1982; Neuvonen and Niemelä, 1983; Fowler, 1985; Leather, 1986). Other specialists consider, however, that the main factor is chemical composition: it is more similar in woody plants, and, hence, greater numbers of polyphagous insects feed on them (Futuyma, 1976; Maiorana, 1978). Subsequent analysis was performed from woody and herbaceous plants separately. The family Rosaceae (Ro), which comprises both woody and herbaceous species, was divided into the corresponding groups and included in both lists. This is why two points, each within the corresponding groups of species (see Fig. 1), represent this family in all figures.

Such a separate analysis provided for a stronger correlation between the species diversity of plants and that of lepidopterans: this factor alone proved to account for 76 and 64% of the species diversity of these insects feeding on woody and herbaceous plants, respectively ( $R^2$ , see Table. 2).

Some families of woody plants obviously attract consumers stronger than other families. In particular, this concerns the Betulaceae (Be) and woody Rosaceae (Ro). Other families, such as the Salicaceae (Sa), are

much less attractive. Among herbaceous dicotyledons, lepidopterans prefer plants of the families Fabaceae (Fa), Polygonaceae (Po), Plantaginaceae (Pl), Rubiaceae (Ru), and Urticaceae (Ur), whereas the Brassicaceae (Br), Caryophyllaceae (Ca), and Scrophulariaceae (Sc) are utilized to a lesser extent than it could be expected. It is noteworthy that none of the macrolepidopterans have host plants in the family Orchidaceae, which may be explained either by their rarity or by their specific chemical composition.

With respect to specialization of lepidopterans in plants of certain families, it is interesting to consider species associated with only one plant family. We found such specialists in 37 out of 59 families (62.7%); i.e., plants of the remaining 22 families are consumed only by polyphagous insects. Most of these families are relatively small taxa that do not attract large numbers of phytophages. In particular, we found no specialists on plants of the families Plantaginaceae, Ericaceae, and Caprifoliaceae, although they proved to be attractive for 60, 57, and 50 species of polyphagous lepidopterans, respectively.

The general situation with specialists and generalists varies depending on the family. There are some small families with a certain specialization. For example, the Notodontidae is specialized mainly in woody plants, with preference for willow and birch species. However, even large families with different specializations of the constituent genera markedly differ from each other in their food spectra. For example, the proportion of polyphagous species in the families Noctuidae and Geometridae is approximately two times greater than the proportion of specialized species, although noctuids are generally more polyphagous and utilize plants of 54 families, compared to 44 families in geometrids. Moreover, geometrids in the Southern Urals are more often found on woody plants than noctuids, except for the Salicaceae, on which the latter prevail (41.1 vs. 22.7%) and the Rosaceae and Ericaceae, on which their proportions are more or less equal (24.9 vs. 26.8 and 8.6 vs. 10.1%, respectively). On woody plants of other families, geometrids are much more numerous than noctuids. Conversely, noctuids prevail over geometrids on herbaceous plants of the families Asteraceae (31.4 vs. 22.2%), Chenopodiaceae (8.2 vs. 2.0%), Plantaginaceae (11.4 vs. 4.5%), Polygonaceae (18.8 vs. 8.1%), Rosaceae (11.4 vs. 4.5%), Urticaceae (11.0 vs. 1.0%), Poaceae (= Gramineae) (26.5 vs. 2.5%), and Cyperaceae (5.3 vs. 0%). The family Rubiaceae is an exception: plants of this family are consumed by 12.6% of geometrids (including specialists), compared to only 5.3% of noctuids.

Taxa of higher rank (the Rhopalocera and Heterocera), each comprising several families, still markedly differ in their food spectra. The former prefer only herbaceous plants, with preference for the families Fabaceae (31.7%), Poaceae (21.8%), Rosaceae (15.5%) and Violaceae (12.0%); the latter, in addition

to some representatives of the Asteraceae (25.0%), Poaceae (14.4%), Fabaceae (13.7%), and Polygonaceae (13.5%), also prefer woody plants of the families Salicaceae (31.1%), Rosaceae (26.7%), Betulaceae (25.6%) and Vacciniaceae (15.5%).

**Changes in the composition of vegetation in the direction from the Southern to the Polar Urals.** The species diversity of plant and animal taxa decreases in the direction from the tropics to the poles, and this decrease is also manifested in the Ural region: 752 plant species in the Southern Urals versus approximately 360 species in the Polar Urals and the area extending to the Ob River. It should also be taken into account that, although the floras of the biological station and, to a lesser extent, the Il'men reserve may be regarded as local, the flora of the Polar Urals does not belong to this category and comprises a greater number of species than any local floras of the northern Ob region. However, the diversity of some plant families (e.g., the Ericaceae and Saxifragaceae) and, the more so, their proportion in the flora markedly increase northward. Several more families retain almost the same numbers of species or they decrease to a lesser degree than the total number of species in the flora (e.g., the Brassicaceae, Juncaceae, Liliaceae, Onagraceae, Ranunculaceae, Rubiaceae, Salicaceae, and Vacciniaceae). The position of some taxa in the flora remains the same in the floras of the Middle and Polar Urals. This concerns the Caryophyllaceae, Cyperaceae, Poaceae, Polygonaceae, Pyrolaceae, Rosaceae, and Scrophulariaceae. Finally, the number of species in some families decreases in a south–north direction more rapidly than that in the flora as a whole. Small families account for less than 1% of the Middle and Southern Ural Floras. Among larger families, this concerns the Asteraceae, Boraginaceae, Campanulaceae, Fabaceae, Lamiaceae, Violaceae, Chenopodiaceae, and Orchidaceae. The last two families are represented in the north by only one species, and the Euphorbiaceae are totally absent. On the whole, the Ural flora in the north loses 38 families but acquires three monospecific families: the Diapensiaceae, Linaceae, and Paeoniaceae. However, the last two families have been described in the floras of both Middle and Southern Urals (*Opredelitel'*..., 1994), and their absence in the study areas is accidental.

As the proportion of the Asteraceae decreases and that of the Poaceae increases in the north, their positions change so that the Poaceae acquire the dominant status. Among ten leading families in the Polar and Middle Urals, eight are common to both regions and two are different (Table 1). The latter are the Salicaceae and Juncaceae in the Polar Urals (the eighth and ninth places) and the Fabaceae and Apiaceae in the Middle Urals (the fifth and tenth places). In the Southern Urals, the Apiaceae and Lamiaceae share the tenth place.

**Changes in trophic conditions for lepidopterans in the direction from the Southern to the Polar Urals.** The diversity of macrolepidopterans decreases

**Table 1.** Lists of the first ten plant families in the Ural floras (figures in parentheses show percentages of the total number of species in the flora)

Place	Southern Urals	Middle Urals	Polar Urals
1	Asteraceae (12.5)	Asteraceae (12.3)	Poaceae (10.9)
2	Poaceae (9.8)	Poaceae (11.0)	Asteraceae (9.2)
3	Cyperaceae (8.4)	Cyperaceae (7.4)	Cyperaceae (8.4)
4	Rosaceae (6.5)	Rosaceae (5.9)	Brassicaceae (7.3)
5	Fabaceae (5.6)	Fabaceae (5.7)	Ranunculaceae (6.1)
6	Brassicaceae (4.7)	Brassicaceae (4.2)	Rosaceae (6.1)
7	Caryophyllaceae (4.7)	Scrophulariaceae (4.1)	Caryophyllaceae (5.3)
8	Scrophulariaceae (3.9)	Caryophyllaceae (3.9)	Salicaceae (4.2)
9	Ranunculaceae (3.6)	Apiaceae (3.5)	Juncaceae (3.6)
10	Apiaceae (3.1)	Ranunculaceae (3.5)	Scrophulariaceae (3.6)
11	Lamiaceae (3.1)		
Total number of families	78	67	50
Total number of general	350	290	167
Total number of species	752	543	358

in this direction even more significantly than that of plants, from 767 to 211 species. However, we are interested in the connections of lepidopterans with plants against the background of the decrease in their species diversity and changes in the structure of vegetation. If the proportion of a certain plant family in the flora and the proportion of lepidopterans associated with this family increased and decreased concordantly, this would be evidence that the dependence of the species richness of lepidopterans on the number of species in plant families, which is fairly high in the south of the forest zone, is retained in the north.

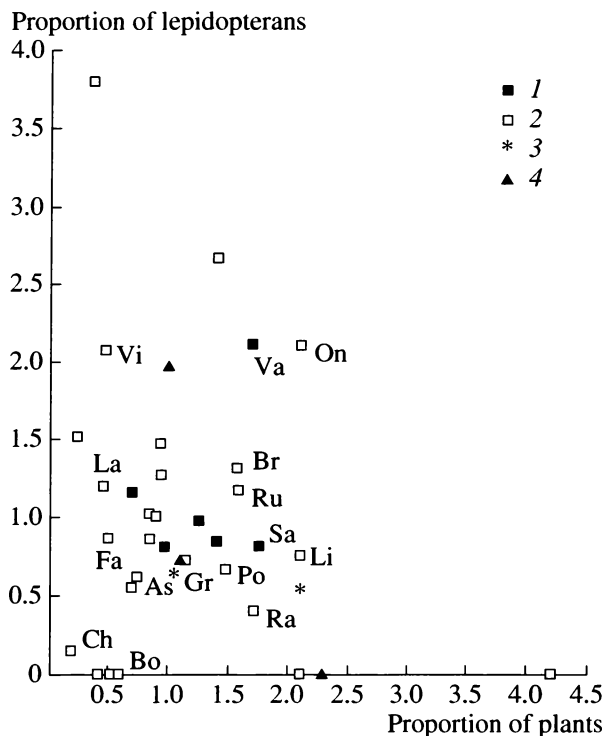
We have several such examples, although they are not many (Fig. 2). Note that we do not refer to small families, because considerable changes in the positions of corresponding points in the diagram may be accounted for by only a few species, and the error may be great. As follows from this figure, a decrease in the proportion of a certain family in the flora is accompanied by a decrease in the proportion of lepidopterans associated with this family (Fig. 2, the lower left field), namely, with herbaceous plants of the families Asteraceae (As; from 21.3 to 13.3%), Fabaceae (Fa; from 17.4 to 14.9%), Chenopodiaceae (Ch), and Boraginaceae (Bo). On the other hand, as the proportion of woody plants of the families Vacciniaceae (Va), Ericaceae, and Empetraceae increase, the proportions of associated lepidopterans also increase from 14.1 to 29.8, from 8.3 to 13.8, and from 0.3 to 5.5%, respectively (Fig. 2, the upper right field). The last two families are not shown in the diagram because of the magnitude of increase in the proportions of these plants or associated insects. Among herbaceous plants, the same is observed with the Onagraceae (On), Brassicaceae (Br), Rubiaceae (Ru), and Saxifragaceae (the last fam-

ily is not shown in the figure for the aforementioned reason).

There are very few families of plants whose species diversity decreases, whereas the proportion of lepidopterans on them increases (the upper left field). In this group, only the Violaceae (Vi) and Lamiaceae (La) are of interest to us. In the former, for example, a decrease is observed in both species diversity (to only two species) and abundance, but the number of lepidopteran species associated with these plants reaches 12, including two specialists.

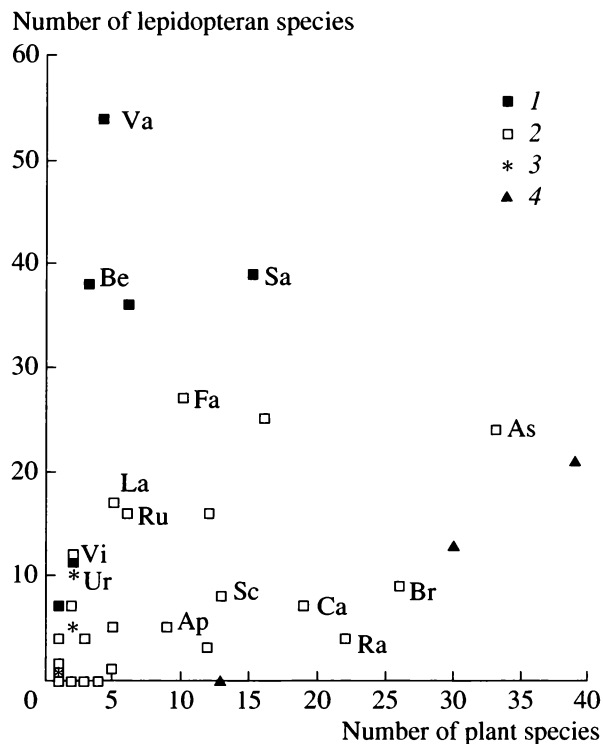
Finally, there is a number of cases in which the proportion of lepidopterans associated with a certain family decreases irrespective of a relative increase in its species richness (the lower right field). This applies to the Salicaceae (Sa; the proportion of insects decreases from 16.0 to 11.6%) and both families of conifers and, among herbaceous plants, the Poaceae (Gr; from 16.0 to 11.6%), Juncaceae, Polygonaceae (Po; from 13.2 to 8.8%), Ranunculaceae (Ra; from 5.5 to 2.2%), and Liliaceae.

The situation in the north (Fig. 3) is largely similar to that in the south of the forest zone; i.e., lepidopterans utilize woody plants more successfully than herbaceous plants. Among dendrophages, species associated with the Vacciniaceae (Va) prevail, but the Betulaceae (Be) are also actively utilized. Preference for the Salicaceae is slightly lower. Insects feeding on herbaceous plants prefer the same dicotyledonous families (Ru, Fa, and Ur) and, in addition, the Lamiaceae (La) and Violaceae (Vi). The plant group characterized by a relatively low degree of utilization includes the same three species as in the south of the forest zone (Br, Ca, and Sc) supplemented with the Apiaceae (Ap), Asteraceae (As), Ranunculaceae (Ra), and the group of graminoids.



**Fig. 2.** Changes in the proportions of plant families in the Polar Ural flora and of lepidopteran species associated with them. Abscissa shows the ratio of the proportion of a plant family in the Polar Ural flora to that in the Southern Ural flora; ordinate shows the analogous ratio for lepidopteran species. For designations, see Fig. 1.

Because of these differently directed changes, the correlation between the species richness of flowering plants and that of lepidopterans becomes much weaker in the north: taken together, woody and herbaceous plants account for only about one-third of the species diversity of lepidopterans (Table 2). These insects utilize 70% of plant families, and only 17 out of 35 of these families provide host plants for specialized insect species.



**Fig. 3.** Correlation between the numbers of plant species in families of the Polar Ural flora and the numbers of lepidopteran species associated with plants of these families. For designations, see Fig. 1.

Considerable changes occur even within the lepidopteran families that are fairly well represented in the Arctic. Among nymphalids, for example, there is an increase in the proportions of species feeding on plants of the Cyperaceae (from 13.8 to 29.3%), Ericaceae (from 4.6 to 9.8%), Vacciniaceae (from 9.2 to 17.1%), and woody Rosaceae (from 20.0 to 34.1%) families; but the proportions of species occurring on representatives of the Asteraceae and Poaceae decrease from 10.8 to

**Table 2.** Coefficients of correlation ( $r$ ) between species richness of plants (by families) and that of lepidopterans associated with these plants

Group of lepidopterans	Southern Urals		Middle Urals		Polar Urals	
	woody plants	herbaceous plants	woody plants	herbaceous plants	woody plants	herbaceous plants
Nymphalidae	0.85	0.61	0.95	0.63	0.49	0.53
Rhopalocera	0.71	0.61	0.85	0.68	0.39	0.60
Geometridae	0.75	0.65	0.78	0.64	0.47	0.35
Noctuidae	0.92	0.83	0.82	0.79	0.48	0.29
Heterocera	0.87	0.79	0.81	0.77	0.58	0.41
Macrolepidoptera	0.87	0.80	0.85	0.80	0.58	0.61

4.9% and from 36.9 to 26.8%, respectively. Macrolepidopterans in the north have not been found on the Boraginaceae, whereas the proportion of such insects recorded in the southern part of the forest zone reaches 15.4% ( $p < 0.05$ ). Geometrids manifest an increase in the proportions of insects feeding on representatives of the Caryophyllaceae (from 5.0 to 10.7%), Empetraceae (from 0 to 7.2%,  $p < 0.001$ ), Ericaceae (from 10.1 to 16.1%), Vacciniaceae (from 20.2 to 37.5%,  $p < 0.05$ ), and Rubiaceae (from 12.6 to 19.6%) and a decrease in the proportion of species found on woody plants of the family Rosaceae (from 26.8 to 10.7%,  $p < 0.05$ ). In noctuids, which expand to the Arctic less successfully, the spectrum of food plants changes even more significantly. The proportions of geometrid species on woody plants increase (from 17.6 to 28% on the Betulaceae; from 0 to 11.4% on the Empetraceae; from 8.6 to 20.0% on the Ericaceae,  $p < 0.05$ ; and from 13.1 to 48.6% on the Vacciniaceae,  $p < 0.01$ ), whereas those on herbaceous plants decrease, especially on the Asteraceae (from 31.4 to 11.4%,  $p < 0.05$ ) and Poaceae (from 26.5 to 5.7%,  $p < 0.05$ ). Therefore, the conclusion that geometrids tend to feed on woody plants and noctuids prefer herbaceous plants (see above) is no more valid in the north of the forest zone, because differences between these groups in the food spectrum become insignificant ( $\chi^2 = 13.18$  vs. 176.97 in the south of the forest zone).

Some changes take place at the level of higher-rank taxa of lepidopterans. However, significant differences between the Rhopalocera and Heterocera in the food spectrum ( $\chi^2 = 334.47$  in the south of the forest zone) are still observed in the north ( $\chi^2 = 113.71$ ) and have the same trend. The only exception concerns the proportions of Rhopalocera and Heterocera feeding on woody plants of the family Rosaceae: 16.9 and 26.7% in the south versus 27.8 and 14.7% in the north of the forest zone, respectively.

## DISCUSSION

The change in the ratio of plants and phytophages in high latitudes allows some authors to conclude that the northward expansion of phytophagous insects is limited by some factors unrelated to their food plants (Downes, 1964; MacLean, 1983; Danks, 1986). In other words, their distribution in the north is governed not only by food supply but also by some other (probably abiotic) powerful factors. An alternative hypothesis is that phytophagous insects in the Arctic have limited possibilities of finding appropriate food plants and synchronizing their seasonal cycles with the cycles of these plants (Danks, 1986).

The processes discussed above lead to the situation that the dependence of lepidopteran species richness on the species richness of the flora sharply decreases (by two-thirds) in the north (see Table 2). Moreover, the numbers of lepidopteran species associated with differ-

ent groups or plants decrease nonuniformly. What is the cause of this phenomenon?

In our calculations, we did not take into account other quantitative parameters of plants as a food resource, such as their abundance and frequency of occurrence in different types of biotopes. The relationship between these parameters of a plant family may sharply differ (for example, the Orchidaceae in the south of the forest zone are represented by a considerable number of rare species). In general, however, they positively correlate with each other, and this correlation is often strong (Neuvonen and Niemelä, 1981, 1983). Thus, the Salicaceae not only occupy an important place in northern floras but are also represented in almost all plant associations, accounting for a large proportion of total phytomass in many of them. At the Kharp Research Station, for example, willows were found in 19 out of 24 plant associations (Gorchakovskii and Trotsenko, 1974) and accounted for the bulk of the shrub layer in open woodland and some types of tundras and open forests. Niemelä and Neuvonen (1983) consider the abundance of plants to be the original cause of the relationship between the species richness of phytophagous insects and that of plants, and we regard this opinion as valid.

In general, trophic connections of phytophagous insects and many other consumers are known in less detail in the north than in the south of the forest zone. However, this circumstance is unlikely to be related to the situation with representatives of Salicaceae and Betulaceae, which are widespread and abundant in the north, or else it would imply a systematic shortage of data on the consumers of precisely these well-studied plant groups.

It should also be taken into account that, using in formal lists of plant species in calculations, we ignore the fact that insects can probably utilize only part of these plants. In the Arctic, many plant species occur in tundra and mountain-tundra biotopes not yet colonized by lepidopterans or have forms with leathery or downy leaves that are poorly accessible to them. Hence, these insects can actually feed on only part of a species in a family. In particular, this concerns willows. These factors concern mainly the quality of food resources, but they affect relevant quantitative parameters of some plant families and can eventually weaken the correlation between insect and plant species richness in the North.

Thus, quantitative parameters of food plants well explain the species diversity of lepidopterans in the south of the forest zone, but their role at the northern boundary of this zone is much less significant. Some groups of plants are abandoned by their consumers at an increasing rate. In the case of grasses, this may be explained by their poor quality as insect food. Other plant species (e.g., of the families Ranunculaceae and Caryophyllaceae) contain poisonous substances, and insects reluctantly establish trophic connections with

these plants even in the southern part of the forest zone. In its northern part, these connections are easily disrupted, although the proportion of such plants in the flora increases.

However, this explanation is not applicable to willows, which have a high nutrient value (MacLean and Jensen, 1985). It is well known that willows provide the most favorable conditions for colonization by insects in the forest zone (Southwood, 1961; Godfray, 1984) and accommodate the richest insect consortia in the tundra (Chernov, 1980; Bogacheva, 1990). Tendencies toward an increase in the proportion of phyllophages feeding on willows at higher latitudes were previously revealed in weevils, leaf beetles, and sawflies (Bogacheva, 1997a). For this reason, we attribute the decrease in this proportion in lepidopterans to certain specific features of this group, the more so that other researchers (Neuvonen and Niemelä, 1983) also emphasize differences in the significance of the same factors for different groups of insects.

A noteworthy fact is that the proportion of lepidopterans associated with evergreen plants increases in the north of the forest zone, although their leaves are not quite suitable for insect feeding. In particular, this concerns representatives of the Ericaceae, Empetraceae, and, in part, Vacciniaceae. These families have markedly improved their position in the flora of the northern Ob region and are abundant in zonal biotopes. Therefore, the main role in this case may be attributed to quantitative factors. However, insects do not establish any specialized trophic connections with evergreens: these plants are included in the broad food spectrum of polyphagous insects, along with deciduous species (e.g., willows or blueberry) or dicotyledonous herbaceous plants.

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