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At the evaluation of fluctuation asymmetry of green plantings of Karaganda region's industrial cities

Studying of specific structure and condition of green plantings at the territory of industrial centers of the Karaganda region (Karaganda, Temirtau, Balkhash, Zhezkazgan) is carried out. The specific structure of wood flora on the surveyed points is presented by 13–18 main species. Vitality of wood plants made from 1 to 3 points. On a scale of the characteristic of environment by means of the fluctuating asymmetry, wood plants have got five marks on all research sites, which ecosystems were in areas with extraordinary anthropogenic pressure.

Key words: Karaganda region, fluctuation asymmetry, green plantings, bio indication.

Actuality

The significant role in neutralization and weakening of negative impacts of industrial zones of the city on people and nature in general is played green plantings. Besides decorative and planning and recreational functions they are carrying out an important protective, sanitary and hygienic role [1, 2]. However, carrying out protective functions, the wood vegetation is affected by industrial pollution.

Ability to receive integrated characteristics of quality of the environment, which is under the influence of all variety of physical, chemical and other factors, takes only biological methods, because live organisms bear the maximum information about habitat.

From all variety of known methods of bio indicative researches, perhaps, one of the fullest methods is to use of manifestations of the fluctuating asymmetry of organisms [3].

Understand as the fluctuating asymmetry (FA) insignificant and the casual (not directed) deviations from strict bilateral symmetry of bio objects [4]. Lack of absolutely symmetric organisms can be regarded as a result of imperfection of the mechanisms controlling ontogenesis, their inability to resist to negative impact of environment [5, 6].

The purpose of the real work — an assessment of manifestations of the fluctuating asymmetry of bilateral signs of sheet plates of Populus nigra and Betula pendula at the territory of industrial cities of Karagandy region.

Objects and methodology

For research of a forest stand as bio indicators of an urban environment, in the cities of Karaganda, Balkhash and Temirtau sites with various anthropogenic pressures were chosen (Table 1). As control environmentally friendly territories — Karkaraly Mountains are chosen. The three-point scale was applied to an assessment of vitality: I — Vitality is good (full) — plants in a phyto coenosis normally blossom and fructify (there are individuals of all age groups), adult individuals reach the sizes, normal for this species; II — Vitality is satisfactory (oppressed) — the plant is oppressed that is expressed in smaller sizes of adult individuals, seed reproduction is impossible; III — Vitality is unsatisfactory (strongly oppressed) — the plant is oppressed so strongly that the sharp deviation in morphological shape of adult plants (branching, a form of leaves, etc.) is observed; seed reproduction is absent (there are no the blossoming and fructifying escapes) [3, 4].

The assessment of a condition of a forest stand was made for establishment of an adverse effect of anthropogenic factors and forecasting of destiny of the studied wood ecosystem:

1 point — healthy trees, without external signs of damages, the size of a gain meets standard;

2 points — the weakened trees. Krone is poorly developed, separate branches dried out. Leaves and needles often with a yellow shade. At coniferous trees have release of pitch and dying off bark on separate sites;

3 points — strongly weakened trees. Krone is poorly developed, with considerable dried branches, dried top. Leaves light green, needles with a brown shade. Leaves small, but happen and are increased. The gain is reduced or is absent. Release of pitch is strong. Considerable sites of bark died off;

4 points — the drying-out trees. Dried branches are on all krone. Leaves small, underdeveloped, pale green with a yellow shade, the early leaf fall is noted. The needles are damaged for 60 % of total. The gain is absent. On trunks signs of settling by bark beetles, bags with a big mustache (a boring fly, an opening on bark, wood);

5 points — dry trees. Krone dry. Krone is dried. Leave aren't present, the needles yellow or brown, are showered or showered. Bark on trunks exfoliates or completely fell down. Trunks are populated with xylophages (consumers of wood) (Table 1).

Table 1

Point of gathering leave probes at the territories of industrial cities of Karagandy region

№ point	Place of leave selection	GPS coordinates	
		Northern latitude	Eastern longitude
Zhezkazgan city			
1	Country massif near airport	47.43910	67.43160
2	Territory near railway station	47.46551	67.41680
3	City Park «Zhastar»	47.47439	67.42962
4	City beach	47.48013	67.43207
5	Mira street	47.48341	67.42765
Balhash city			
6	2 km from industrial zone	46.50063	74.57525
7	City park	46.50248	74.58217
8	Lenin street	46.50.211	74.59103
9	Avenue near by city Moshe	46.50418	75.00156
Karkaraly mountains			
10	Touristic place, 8 km from Karkaraly city	49.48448	75.45817
11	Rest house	49.42065	75.45268
Karagandy city			
12	Zelinsky street, Prishahtinsk	49.53663	73.04951
13	Prishahtinsk, park of city hospital	49.54481	73.05009
14	Prishahtinsk, territory of auto park № 2	49.55249	73.04292
15	Square near Gapeev street, 33	49.74316	73.15356
16	Square near Miners prospect	49.78139	73.13844
17	Square of Gogol street	49.81938	73.09742
18	Square of Buhar-Zhyrau street	49.80769	73.08305
19	Central city park	49.80751	73.07992
20	Maykuduk, city park	49.89226	73.19808
Temirtau city			
21	Karagandy street	50.03322	73.00094
22	Office of Karagandy Steel Plan	50.03148	73.00819
23	Mechanized foundry of Karagandy Steel Plan	50.03619	73.02023
24	City park	50.03612	72.59897
25	Bus station	50.03749	72.57034
26	Metallurg prospect	50.03342	72.58014

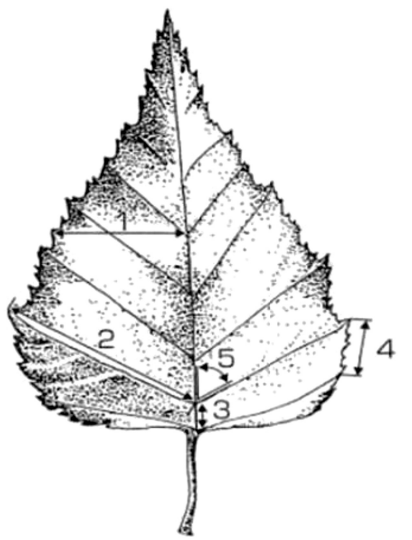
Impact of the environment into wood organisms was estimated on the basis of FA of leaves, that is deviations from bilateral symmetry [5, 6]. From each leaf removed indicators on five measurements from the left and right parties (Fig.).

The coefficient of fluctuation asymmetry was calculated on a following formula:

$$\overline{A_1} = \frac{1}{mn}\sum_{i=1}^{m}\ \sum_{j=1}^{n}\frac{\left|L_{ij} - R_y\right|}{\left(L_{ij} - R_{ij}\right)},$$

where m — number of objects; n — number of signs; L, R — the size of signs at each object at the left and on the right concerning the symmetry plane.

For the characteristic of a condition of the environment the absolute five-point assessment of quality of the environment on degree of a deviation of its state from an ecological optimality (Table 2) is used.



1 — leaf half width (in the middle of a leaf plate);

2 — length of the second vein from the leaf basis (to the left and to the right from the central vein);

3 — distance between the first and second veins, (to the left and on the right sides);

4 — distance between the first and second veins, reading out from a scape, from the external leaf edges (to the left and to the right from the central vein);

5 — a tilt angle of the second vein to central (to the left and to the right)

Figure. Schema of leaf measurements

Table 2

A scale of the characteristic of an environment state using of FA method

Mark	Magnitude of FA	Condition of environment
1	<0,40	Situation conditionally normal
2	0,40–0,44	Small deviations from a normal state
3	0,45–0,49	Big deviations from a normal state
4	0,50–0,54	Dangerous deviations
5	>0,54	Critical state

Results and their discussion

Results showed that the specific structure of wood flora is presented by 13–18 main species, among which *Fraxinus lanceolate, Fraxinus pennsylvanica, Populus alba, Populus nirga, Populus balsamifera, Betula pendula, Acer negundo, Acer tatarica, Ulmus pumila, Pinus sylvestris* and other. Most often meet are following: *Acer negundo, Ulmus pumila, Populus nirga*, these plants grow practically on each surveyed point. Other species meet sporadically, are more often dated for certain inhabited massifs, parks and squares (Table 3).

Table 3

Condition of wood plantings of industrial cities of Karagandy region

№ point	Vitality	Assessment of a condition of a forest stand	№ point	Vitality	Assessment of a condition of a forest stand
1	2	3	14	2	1
2	2	4	15	2	2
3	2	3	16	3	3
4	2	4	17	2	2
5	1	1–2	18	3	3
6	2	3–4	19	3	3
7	2–3	4–5	20	1	2
8	2	3	21	1	1
9	2	3	22	2–3	2
10	1	1	23	2	2
11	1	1	24	1	1
12	2	1	25	2	2
13	2	1	26	3	1–2

Good vitality (1 point) is noted for wood plants from Karkaraly mountains, city park of Maykuduk (Karaganda), Mira Street (Zhezkazgan) and Karagandy Street (Temirtau). Satisfactory vitality (2 points) is noted for the main volume of green plantings of the industrial cities. Unsatisfactory (3 points) the state is noted in the square on Gogol Street and in the central recreation park (Karaganda), and also in the territory of steel plan (Temirtau).

The assessment of a condition of wood stand showed that 1 point was gained by plantings of Karkaraly city, the most part of plantings of Karaganda, 2 points in Temirtau. Plantings of Balkhash and Zhezkazgan gained 2–3 points that spoked about their critical condition.

On all research sites conducted researches for determination of size of the fluctuating asymmetry, for the purpose of definition of environment state which the wood vegetation (Table 4) grows.

Table 4

Results of assessment of FA of leave of wood plants

№ point	Species	Magnitude of FA	Mark	№ point	Species	Magnitude of FA	Mark
1	Populus nirga	0.55534	5	14	Populus nirga	3.74297	5
2	– " –	0.71964	5	15	– " –	0.92186	5
3	– " –	0.47574	3	16	– " –	0.37638	1
4	– " –	0.57371	5	17	– " –	0.45245	3
5	Betula pendula	0.22080	1	18	– " –	0.43864	2
6	Populus nirga	2.16225	5	19	– " –	0.43618	2
7	– " –	0.33354	1	20	– " –	0,51207	4
8	– " –	0.30563	1	21	Betula pendula Populus nirga	0.30901 0.64397	1 5
9	– " –	0.01101	1	22	Betula pendula Populus nirga	1.87246 1,91603	5 5
10	Betula pendula	0,33567	1	23	Populus nirga	3.55829	5
11	Betula pendula	0.22080	1	24	Populus nirga	1,20538	5
12	Populus nirga	1.93295	5	25	Betula pendula Populus nirga	0.38316 0,91290	1 1
13	Populus nirga	1.96209	5	26	Betula pendula	0.02897	1

The smallest values of FA which correspond to normal conditions of the environment are noted for park zones, squares, forests and few brisk streets for all of the industrial cities, and also for Karkaraly mountains. The described points can be carried to territories with conditionally normal state of environment.

The most critical indicators of FA (4–5 points) are noted for inhabited massifs and industrial zones of Temirtau, industrial zones of Karaganda, Balkhash and Zhezkazgan. Sites are characterized by the raised transport loading, a close arrangement of the industrial enterprises with emissions. These values correspond to sites with critically broken ecosystems.

It should be noted that it is a little territories with average values of FA (2–3 points). There are following: Bukhar-Zhyrau Avenue, Gogol Street, Central city park (Karaganda), park Zhastar (Zhezkazgan). Here is observed transition from small deviation of environment condition until essential violations.

Thus, in the territory of the Karaganda region in the territory of all industrial cities is observed the extraordinary anthropogenic pressure testifying to a critical and dangerous state of environment.

Conclusion

Following the results of the executed researches it is possible to make the following conclusions:

1. The specific structure of wood flora of Karagandy region on the surveyed points is presented by 13–18 main species. Most often meet are Ulmus pumila, Populus, Fraxinus, Acer; other species met sporadically, were more often dated for certain inhabited massifs, parks and squares.

2. Vitality of wood plants made from 1 to 3 points. Good vitality (1 point) is noted for wood plants from Karkaraly mountains, city park of Maykuduk (Karaganda), on Mira St. (Zhezkazgan) and on Karagandy St. (Temirtau). Satisfactory vitality (2 points) is noted for bulk of green plantings of the industrial cities. Unsatisfactory (3 points) the state is noted in the square on Gogol Street and in the central recreation park (Karaganda), and also in the territory of steel works (Temirtau).

3. The assessment of a condition of a forest stand showed that 1 point was gained by plantings of Karkaraly city, the most part of plantings of Karaganda, 2 points in Temirtau. Plantings of Balkhash and Zhezkazgan gained 2–3 points that spoke about their critical condition.

4. In the territory of the industrial cities of the Karaganda region the extraordinary anthropogenic loading testifying to a critical and dangerous state of environment is observed.

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Қарағанды облысының өндірістік қалаларының жасыл алқаптары асимметриясының ауытқуын бағалау

Қарағанды облысының өндірістік орталықтары аумағындағы (Қарағанды, Теміртау, Балқаш, Жезқазған) жасыл алқаптарының жағдайы мен түрлік құрамына зерттеу жүргізілді. Қарағанды облысының зерттелетін нүктелерінде ағашты флораның түрлік құрамы 13–148 негізгі тұқымдармен ұсынылған. Ағаш өсімдіктерінің өміршеңдігі 1-ден 3 балға дейін жетті. Асимметрия ауытқуы көмегімен қоршаған ортаны сипаттау шкаласы бойынша ағашты өсімдіктер барлық зерттелетін аудандарда 5 балға тең болды, яғни аудандардағы экожүйе төтенше антропогендік жүктememен сипатталған.

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К оценке флуктуирующей асимметрии зеленых насаждений промышленных городов Карагандинской области

Авторами проведено изучение видового состава и состояния зеленых насаждений на территории промышленных центров Карагандинской области (Караганда, Темиртау, Балхаш, Жезказган). В статье видовой состав древесной флоры Карагандинской области на обследованных точках представлен 13–148 основными породами. Жизненность древесных растений составила от 1 до 3 баллов. По шкале характеристики окружающей среды с помощью флуктуирующей асимметрии древесные растения на всех исследовательских участках растения получили пять баллов, т.е. экосистемы в районах с чрезвычайной антропогенной нагрузкой.