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INHALT

VLADIMIR SUKACHEV'S CONCEPT OF BIOGEOCOENOSIS

Tatjana Petzer

ECOSYSTEM AND/OR BIOGEOCOENOSIS (BGC)

In search for an ecological concept defining a »whole complex of organisms inhabiting a given region«[1] with more methodological value than ›complex organism‹ or ›biome‹ and ›biotic community‹, the British phytocenologist Arthur Tansley introduced the term *ecosystem* (from Greek οἶκος ›household‹, and σύστημα ›composite whole‹) in 1935. Referring to the physical notion of ›system‹ as an entity, he linked the organism-complex to the whole complex of habitat factors, blurring the division between natural and anthropogenic environments. Only after the Second World War did Tansley's concept receive broader recognition when the brothers Eugene and Howard Odum framed ecosystem ecology in the 1950s–1960s by linking the natural and social sciences and introducing cybernetic methods into the research of ecosystems.[2]

Independently of each other, other scientists from different countries also recognized the interconnectedness of all phenomena on the Earth's surface, resulting in the parallel coining of various notions. The Russian Botanist Vladmir Sukachev (1880–1967) introduced the term *biogeotsenoz* (biogeocoenosis or biogeocoenose, from Greek βίος ›life‹, γῆ ›earth‹, and κοινός ›common‹),[3] which was broadly used in the Soviet Union and throughout Eastern Europe. It was introduced into Russian in two stages: Following the forestologist Georgii Morozov (1867–1920), who systematically implemented Karl Möbius's term biocoenosis,[4] Sukachev first suggested the term *geotsenoz* (geocoenosis) in 1942.[5] It was meant to link the earth's surface with its inhabitants and abiotic environmental factors in a dynamic unit. However, in 1944, he changed geocoenosis into biogeocoenosis (in the following: BGC), implementing an integral connection with Vladimir Vernadsky's (1863–1945) concepts of the biosphere and the biogeochemical cycles.[6] According to Sukachev, BGC came close to Tansley's notion of the ecosystem which also brings together a biocoenosis with its habitat (the ecotope). However, both terms were not used synonymously: as a more general term, ecosystem was not precise enough to classify the unit of nature itself, whereas the BGC, in accordance with Vernadsky's concept of ›living matter‹,[7] did not include all abiogenic abiotic factors of the ecosystem. Also, the notions of ›facies‹ and ›landshaft‹, which were used by physical geographers, were discussed as similar conceptualization.[8]

1 A[rthur] G. Tansley: »The Use and Abuse of Vegetational Concepts and Terms«, in: *Ecology* 16 (1935), no. 3, pp. 284–307, here p. 299.

2 E[ugene] P. Odum: »The Strategy of Ecosystem Development«, in: *Science* 164 (1969), pp. 262–270. On the popularization and transformation of the concept of the ecosystem see Frank Benjamin Golley: *A History of the Ecosystem Concept*, New Haven: Yale University Press, 1993, ch. 4.

3 The term is also spelled ›biogeocenosis‹.

4 On the concept of biocoenosis see Karl A. Möbius: *Die Auster und die Austernwirthschaft*, Berlin: Wiegandt, Hempel & Parey 1877, pp. 72–87.

5 V[ladimir] N. Sukachev: »Ideia razvitiia v fitotsenologii« [The Idea of Development in Phytocenology], in: *Sovetskaia botanika (*1942), no 1–3, pp. 5–17. Id.: Razvite rastitel'nosti kak ėlementa geograficheskoi sredy v sootnoshenii s razvitiem obshchestva« [The Development of Vegetation as an Element of the Geographical Environment in Relation to the Development of the Community], in: S[ergei] A. Bogoslovskii et. al: *O geograficheskoi srede v lesnom proizvodstve* [On the Geographical Environment in Forest Production], Leningrad: Izd.-vo Lesotekhnich. akad. 1940, pp. 54–62.

6 V[ladimir] N. Sukachev: »O principakh geneticheskoi klassifikatsii v biogeotsenologii« [On the Principles of Genetic Classification in Biogecoenology], in: *Zhurnal obshchei biologii* 5 (1944), pp. 213–277.

7 See the contribution by Georgy S. Levit and Alexander A. Protasov in this issue.

8 V[ladimir] N. Sukachev: »O sootnoshenii poniatii geograficheskii landshaft i biogeotsenoz« [On the Correlation of the Concepts of Geographical Landscape and Biogeocoenosis], in: *Voprosy Geografii* 16 (1949), pp. 45–60. Id.: »Sootnoshenii poniatii ›biogeotsenoz‹, ›ėkosistema‹ i ›fatsiia‹«

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In the GDR, Russian immigrant Alexis Scamoni was professor at the Faculty of Forestry (1948–1963), which was transferred from the Humboldt University of Berlin to Eberswalde. There, he founded the School of Vegetation Research on the basis of Sukachev's concept.[9] Scamoni particularly emphasized the interdisciplinary approach initiated by Sukachev, which led to a cooperation between geology, geography, the branches of soil science, climatology, meteorology, vegetation science, ecology and zoology, as well as planning and economics.[10] In the late 1960s, the Soviet volume *Struktura i formy materii* (Structure and forms of matter) which introduced natural science concepts and methods into the context of dialectical materialism, including Sukachev's concept of BGC was translated into German.[11] In turn, Rolf Löther, the East German historian and philosopher of science in the fields of biology and medicine, quotes Sukachev's essay in his book *Biology and Philosophy*. However, instead of highlighting Sukachev's differentiation from the notion of the ecosystem, Löther cites the latter in parentheses – that is, as a synonym to BGC.[12] To him, the difference was of no concern as he was not interested in the exact and applied science, but rather in the philosophical question of scientific development – to understand life as an interaction of biotic and abiotic factors, of material and energy cycles in which the non-living environment is not only involved, but represents a driving factor of co-evolution. Moreover, he focused on the BGC as the scene of interaction, of (self-)regulation, and of radical change due to humanity's activity. Regarding the transition from the biotic forms of the movement of matter towards the social forms of the movement of matter, Löther points to Vernadsky's concept of the noosphere as well as to the introduction of cybernetics into evolutionary biology by Ivan Shmal'gauzen (1884–1963). The mathematical modelling of the BGC was also highlighted by Sukachev himself in the last chapter of his wide-reaching book on *Forest Biogeocoenology*, which was immidately translated into English.[13] A reviewer in the USA, a forester of Russian decent and educator who did not know about the translation commented:

»Those who know the Russian language will note that the book provides a complete account of the development of the ecological (if I may use an obsolete term) concept in Russia. The bibliography of more than 1000 Russian publications (up to 1964 and with a few titles in Ukrainian) will make the volume invaluable for reference purposes. The list of literature in Western languages includes some 500 titles (up to 1962)«.[14]

In 1971 and 1972, the first East-West meetings in the realm of the geographical sciences took place in Hungary and Canada with panels on »Man and Environment«. Here, the notion of BGC attracted international attention.[15] Also, a book translation com-

[Relationship of Biogeocoenosis, Ecosystem and Facies], in: *Pochvovedenie* 6 (1960), pp. 1–10; Engl. transl.: *Soviet Soil Science* 6 (1960), pp. 579–581. Id.: »Osnovnye poniatiia lesnoi biogeotsenologii. Biogeotsenoz kak vyrazhenie vzaimodeistviia zhivoi i nezhivoi prirody na poverkhnosti Zemli. Sootnoshenie poniatii ›biogeotsenoz‹, ›ėkosistema‹, ›geograficheskii landshaft‹ i ›fatsiia‹« [Fundamental Concepts of Forest Biogeocoenology. Biogeocoenosis as an Expression of the Interaction of Living and Nonliving Nature on the Earth's surface. The Correlation of the Concepts of ›Biogeocoenosis‹, ›Ecosystem‹, ›Geographical Landscape‹, and ›Facies‹], in: id., N[ikolai] V. Dylis (eds.): *Osnovy lesnoi biogeotsenologii*, Moscow: Nauka 1964, pp. 5–49.

9 Alexis Scamoni: »Biogeozönose – Phytozönose« (1960), in: Reinhold Tüxen (ed.): *Biosoziologie. Bericht über das Internationale Symposium in Stolzenau/Weser 1960*, Den Haar: Dr. W. Junk 1965, pp. 14–22.

10 Ibid., p. 19. A proper explanation of the term is given by M[artin] Schellhorn: »Biogeozönose«, in: *Philosophie und Naturwisssenschaften. Wörterbuch zu den philosophischen Fragen der Naturwissenschaften*. 3., vollst. überarbeitete Auflage. Bonn: Pahl-Rugenstein Nachf. 1997, S. 127–129. See also the mediation work of the Austrian botanist, who was born in Brno, educated in Switzerland and taught in Innsbruck, Helmut Gams: »Aus der Geschichte der Synökologie und Ökosystemforschung besonders in den Alpen und in Osteuropa« (Ljubljana 1975), in: *Mitteilungen der Ostalpin-Dinarischen pflanzensoziologischen Arbeitsgemeinschaft* 14 (1978), pp. 159–164.

11 V[ladimir] N. Sukachev: »Struktura biogeotsenozov i ikh dinamika« [The Structure of Biogeocoenoses and Their Dynamics], in: *Struktura i formy materii*, Moscow: Nauka 1967, pp. 560–577. Ger.: W[ladimir] N. Sukatschow: »Die Struktur der Biogeozönosen und ihre Dynamik«, in: *Struktur und Formen der Materie*, Berlin: Deutscher Verlag der Wissenschaften 1969, pp. 488–503.

12 Vgl. Rolf Löther: *Biologie und Weltanschauung. Eine Einführung in philosophische Probleme der Biologie vom Standpunkt des dialektischen und historischen Materialismus*, Leipzig: Urania-Verlag 1972, p. 49, 47.

13 Sukachev, Dylis: *Osnovy* (note 8); Engl. transl.: ead.: *Fundamentals of Forest Biogeocoenology*, Edinburgh, London: Oliver and Boyd 1964. Recounting the history of the concept of biogeocoenosis, Sukachov and Dylis mentioned the contribution of Vladimir Stanchinskii (1882–1942), who pioneered ecological energetics, to the development of biogeocoenology, and had fallen prey to the purges.

14 Nicholas T. Mirov: »Forest Ecology: Sukachev's Concept of ›Biogeocoenoses‹: Fundamentals of Forest Biogeocoenology. V. N. Sukachev and N. V. Dylis, Eds. Botanical Institute and Laboratory of Forest Science, Academy of Sciences of the U.S.S.R., Moscow, 1964. 574 pp. Illus.«, in: *Science* 148 (1965), no. 3671, p. 828.

15 See the comparative conceptual analysis by West-German geographer Carl Troll: »Landscape ecology (geoecology) and biogeocoenology: a terminology study«, in: *Geoforum* 8 (1971), pp. 43–46.

missioned by the NASA technical translation service of the Soviet Space biology series *Modelling Biological Systems* provided an overview on cybernetical approaches to biological associations such as the BGC.[16] The term itself was introduced as denoting the same as ›ecological system‹, but with an annotation by the authors stating that they have noticed a certain shift in the usage and meaning of these terms.[17] The following will trace the conceptual divergence from the perspective of the most obvious difference: the establishment of a discipline.

BIOGEOCOENOLOGY

While the ecological system is arbitrary in size and might equal the smallest unit of the terrestrial surface and as well as whole Earth, the BGC refers to an actually existing, definable territory. BGCs are visually distinguished by their vegetation, their height, and their closeness of tiers. They are usually named after the plants that dominate their different tiers. A BGC evolves from the continuous interactions between all components, (fig. 1)[18] known as structural-functional parcels (*partselly*), including living and dead organic matter, soil, and atmosphere:

»A Biogeocoenose is a combination on a specific area of the earth's surface of homogeneous natural phenomena (atmosphere, mineral strata, vegetable, animal, and microbiotic life, soil, and water conditions), possessing its own specific type of interaction of these components and a definite type of interchange of their matter and energy among themselves and with other natural phenomena, and representing an internally-contradictory dialectical unity, being in constant movement and development«.[19]

In its complexity, this definition of BGC as a coevolutionary unit of the biosphere provided the foundation for Sukachev's interdisciplinary science of biogeocoenology.[20] The concept served the investigation of the laws of matter and energy's processes of environmental transformation. As a diagnostic tool, it enabled the systematic land classification and mapping as well as, last but not least, the regulation of the BGC.

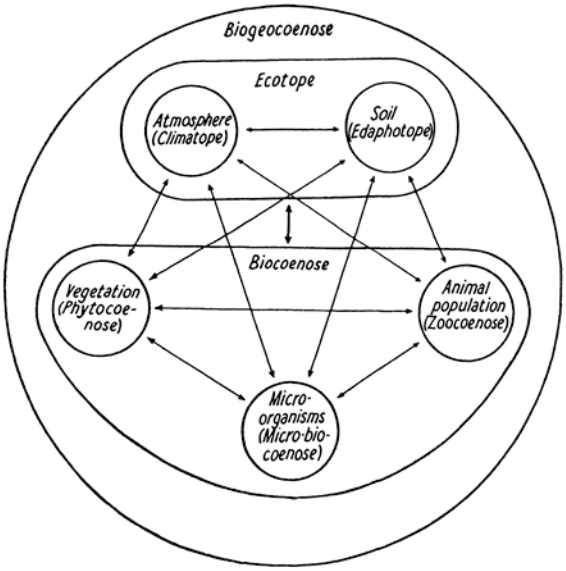

Fig. 1: Vladimir Sukachev's general scheme of biogeocoenosis

As there were many parallel developments within other emerging cross-border studies such as geobotany, geobiology, or vegetation geography, researchers with a different scientific background reacted similarly to the ecosystem-BGC-equation.[21] The mapping of ecological sciences by Czech

16 I[urii] M. Svirezhev, E[vgenii] Ia. Elizarov: *Problemy Kosmicheskoi Biologii*, vol. 20: *Matematicheskoe modelirovanie biologicheskikh sistem*, Moscow: Nauka 1972; Engl. transl.: *Problems of Space Biology, vol 20: Mathematical Models of Biological Systems*, NASA TT F-780, 1973.

17 Ibid., p. 5.

18 Engl.: Sukachev, Dylis: *Fundamentals* (note 13), p. 27.

19 Ibid., p. 26. Rus.: Sukachev, Dylis: *Osnovy* (note 8), p. 329: »Биогеоценоз – это совокупность на известном протяжении земной поверхности однородных природных явлений (атмосферы, горной породы, растительности, животного мира и мира микроорганизмов, почвы и гидрологических условий), имеющая свою особую специфику взаимодействия этих слагающих ее компонентов и определенный тип обмена веществом и энергией их между собой и с другими явлениями природы и представляющая собой внутренне противоречивое диалектическое единство, находящееся в постоянном движении, развитии«.

20 V[ladimir] N. Sukachev: »Osnovy teorii biogeotsenologii« [Fundamentals of the Theory of Biogeocoenology], Iubileinyi sbornik, posviashchennyi 30-letiiu Velikoi Oktiabr'skoi sotsialisticheskoi revoliutsii, part 2, Moscow, Leningrad: Izd.-vo AN SSSR 1947, pp. 283–304. Id.: »Lesnaia biogeotsenologiia kak teoreticheskaia osnova lesovodstva i lesnogo choziaistva« [Forest Biogeocoenology as a Theoretical Basis for Forestry and Forest Management], in: id. (ed.): *Voprosy lesovedeniia i lesovodstva: dokl. na V. Vsemir. lesn. kongresse* [Issues of Forest Science and Forestry: Papers presented at the V. World Forestry Congress], Moscow: Izd.-vo AN SSSR 1960, pp. 5–18. Id., N[ikolai] V. Dylis (eds.): *Programma i metodika biogeotsenologicheskikh issledovanii* [Biogeocoenological Research Programme and Methodology], Moscow: Nauka 1966.

21 Jiří Pacltl: »Bionomie und Ökologie«, in: *Phyton* 7 (1957), no. 1–3, pp. 225–227. Note the turning over of syllables to change meaning: Alois Zlatník: *Ekologie krajiny a geobiocenologie: jako vědecký podklad ochrany přírody a krajiny* [Landscape Ecology and Geobiocoenology: As a Scientific Basis for Nature and Landscape Conservation], Brno: VŠZ 1975.

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botanist Jiří Paclt (Slovak Academy of Sciences) can be summarized as such: biogeocoenology = geobiology, geobiology = biocoenology, biocoenology = synecology, synecology = geobiology, and ecology = synecology and biocoenology; accordingly, this field can simply be called ecology. For the complementary field, i.e., auto-ecology and ethology, Paclt suggested the term ›bionomy‹. The intention and impact of biogeocoenology remained unrecognized. At that time, however, both the approaches of biogeocoenology and, above all, the subdivision of forest biogeocoenology was highly esteemed within the applied sciences for its clear praxiological orientation and practical implication in environmental preservation. Sukachev's detailed empirical research into the specific conditions of forests resulted in the early recognition of their importance to hydrology and the anthropogenic regional climate change in deforested areas. This ecological understanding gave rise to the Great Stalin Plan for the Transformation of Nature in 1948, with a special emphasis on the field-protective afforestation and the promotion of watersheds. In the 1950s, the totalitarian party-scientist Trofim Lysenko, who had previously initiated the destruction of Soviet genetics and weakened of ecologists, attempted to extend his power to the control of forestry and the Transformation Plan. At this point, due to his civil and scientific standing[22], Sukachev was already a sufficiently distinguished individual to oppose Lysenko. The failures of Lysenko's steppe afforestation were reported to the highest levels and the absurdity of his pseudo-scientific theory was torn apart in the journals. Not only did Sukachev thus become a symbol for both the early ecological opposition and the largest conservation organization in the world at that time, but ecological consciousness also became a synonym for opposing ideology.[23] The renowned geneticist Nikolai Timofeev-Resovskii (also Timoféeff-Ressovsky, 1900–1981) is a prominent example for this movement which aimed to re-establish the ethics and ecology of science.

Acting as head of the Department of Experimental Genetics in Berlin-Buch during the interwar period, Timofeev-Resovskii was imprisoned after the Second Word War, incarcerated in a Gulag camp, and later transferred to a so-called *sharashka*[24] to work at a secret laboratory where he helped develop the Soviet atomic bomb project. Following his release (but not rehabilitation),[25] he was given a position at the Ural Branch of the Academy of Sciences in Sverdlovsk (today Yekaterinburg) where he headed the Department of Biophysics (1955–1964), a rare stronghold of ›Western‹ genetics in the years of Lysenko's decline. Additionally, he conducted experimental biogeocoenological studies at the biological station Miassovo in the Il'menskii zapovednik near the city of Miass (Chelyabinsk region).[26] Due to his interaction with scientists from other research areas, this theory developed into a dynamic field of Soviet science.

INTERDISCIPLINARY LEGACY

At the biological station Miassovo, Timofeev-Resovskii immediately began to conduct experiments on the treatment of water contaminated by radioactive slags, as well as on the radioactive stimulation of plants. Based on the experiments' results, Timofeev-Resovskii systematized the distribution and accumulation patterns of radioactive isotopes cycling in a BGC, their selective accumulation in organisms, and the migration within their communities. This new direction in research, the experimental radiation biogeocoenology became the objective of his doctoral thesis[27] and ultimately provided the foundation for handling the consequences of contamination and radiation accidents.

22 Sukachev headed the Botanical Society, the Academy of Science's Institute of Forestry, the Academy Presidium's Commission on the Zapovedniki (strictly protected nature reserves), and the editorial boards of the Botanical Journal and the Bulletin of Moscow Institute of Biology. In 1955, he was elected president of the Moscow Society of Naturalists, one of the most prestigious societies of natural sciences in Eastern Europe.

23 In the GDR, people followed Sukachev's opposition against Lysenko in the discussion on steppe afforestation in the early 1950s, however the ideological critique of biogeocoenology earned by Lysenkoists had fortunately no devastating effects, see Arnold Buchholz: »Kritik sowjetischer Biologen an Lysenko«, in: *Osteuropa* 3 (1953), no. 4, pp. 251–256.

24 Actually, the Russian word ›sharashka‹ denotes a shabby business based on fraud and extortion. Dissidents used the term to refer to those special Gulag prisons, in which incriminated scientists were gathered to supposedly continue their research work. In reality, however, they were misused by the government to aid the secret military developments.

25 Raissa L. Berg: »Defense of Timoféeff-Ressovsky«, in: *The Quarterly Review of Biology* 65 (1990), no. 4, pp. 457–479.

26 N[ikolai] V. Timofeev-Ressovskii: »Primenenie izluchenii i izluchatelei v èksperimental'noi biogeotsenologii«, [Radiation and Emitter Applications in Experimental Biogeocoenology], in: *Botan. Zhurnal* 42 (1957), no. 2, pp. 161–194.

27 N[ikolai] V. Timofeev-Ressovskii: *Nekotorye problem radiacionnoi biogeotsenologii* [Some Problems of Radiation Biogeocoenology], Sverdlovsk: Institut biologii UF AN SSSR 1962. Id.: »Avtoreferat« (The Author's Dissertation Abstract), in: *Problemy kibernetiki* 12 (1964), pp. 201–232. The DSc (as highest science) degree was finally approved after Lysenko's fall.

With Stalin's death in 1953, scientists began fighting for the acknowledgment of genetics and cybernetics (which was also condemned as a reactionary imperialist science). Informal exchange between mathematicians, physicists, and biologists flourished in the circles surrounding Timofeev-Resovskii at Miassovo and the Soviet pioneer of computer science Aleksei Lapunov (1911–1973) in Moscow. One of the key intellectual achievements of this collaboration was Liapunov's mathematical modelling of biological analysis and cybernetic regulation mechanisms on the BGC level.[28] Timofeev-Resovskii defined BGC as a ›biochorological‹ unit, the boundaries of which are determined by the synthesis of biostratigraphic data, as well as by the existence of a dynamic equilibrium as its main characteristic.[29]

As already mentioned above, the last chapter of Sukachev's and Dylis' *Fundamentals of Forest Biogeocoenology* was, as the title suggests, dedicated to the »opportunities of applying the theories and methods of cybernetics to forest biogeocoenology«.[30] It confirmed the prerequisites for the use of a cybernetic approach, confirming that the BGC is based on phenomena of self-regulation (*samoreguliaciia*) and can thus be regarded as a complex system. In the context of evolutionary biology,[31] Shmal'gauzen emphasized the BGC as being the ›regulator‹, i.e., the main stabilizing factor of evolution (fig 2).[32]

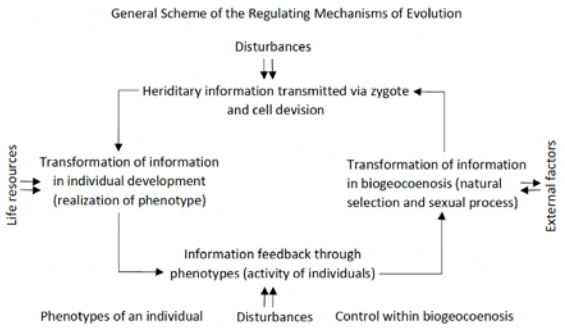

Fig. 2: Ivan Shmal'gauzen's general scheme of the regulating mechanism of evolution

Against the background of the emerging field of energetics, Mikhail Budyko (1920–2001) explored the global energy flows focusing on the human metabolism with nature. His methods for calculating the energy and heat balance became a pioneering element for further studies on physical and global climatology. Together with Evgenii Fedorov (1910–1981), he delineated the ice-albedo effect as a global warming feedback mechanism and openly addressed the anthropogenic effects on climate change as early as in 1961, thus developing the nuclear winter theory.[33] Not only was the anti-nuclear movement an issue of peace, but it was also closely related to environmental issues.

For the emerging environmental movement of the 1970s, Marx's theory of socio-ecological metabolism became just as important as it was for Sukachev's biogeocoenology. In his essay collection titled *Geography and Ecology*, the pedologist Innokentii Gerasimov confronted the Soviet public with serious ecological problems. Ivan Frolov, chief editor (1968–1977) of the USSR's leading philosophy journal *Voprosy filosofii* (Problems of Philosophy), called for a restructuring of human society on materialist-ecological grounds. The roots of Soviet opposition lie in the ecological movement, and the government's non-adequate response to the Chernobyl nuclear catastrophe initiated the end of the Soviet Union.

28 A[leksei] A. Liapunov, I[gor] V. Stebaev: »O biogeotsenologicheskom urovne upravleniia v ramkakh biosfery« [On the Biogeocoenological Level of Control within the Biosphere], in: *Problemy kibernetiki* 11 (1964), pp. 147–151. A[leksei] A. Liapunov: »O matematicheskom modelirovanii balansovikh sootnoshenii v biogeotsenoze«, in: *Zhurnal obshchei biologii* 29 (1969), no. 6, pp. 629–644.

29 N[ikolai] V. Timofeev-Resovskii: »O nekotorykh principakh klassifikatsii biokhorologicheskikh edinits« [On Some Principles of the Classification of Biochorological Units], in: *Trudy Instituta biologii UF SSSR* 27 (1961), pp. 23–29. Id., A[natolii] N. Tiuriukanov: »Ob èlementarnykh biokhorologicheskikh podrazdeleniiakh biosfere« [On the Elementary Biochorological Units of the Biosphere], in: *Biull. Moskovskogo obshchestva ispytivatelei prirody. Otd. Biol* 71 (1966), no. 1, pp. 123–132. Ead.: »Biogeotsenologiia i pochvovedenie« [Biogeocoenology and Soil Science], in*: Biull. MOIP. Otd. Biol.* 72 (1967), no. 2, pp. 106–117.

30 V[ladimir] N. Sukachev, N[ikolai] V. Dylis: »O vozmozhnosti primeneniia idei i metodov kibernetiki v lesnoi biogeologii« [On the Possibility of Applying the Ideas and Methods of Cybernetics to Forest Biogeocoenology], in: ead.: *Osnovy* (note 8), pp. 501–510.

31 I[van] I. Shmal'gauzen: »Osnovy èvoliutsionnogo protsessa v svete kibernetiki« [Fundamentals of the Evolutionary Process in the Light of Cybernetics], in: *Problemy Kibernetiki* 4 (1960), pp. 121–149.

32 1968, S. 40. Translation of terms follows Georgy S. Levit, Uwe Hossfeld, Lennart Olsson: »From the ›Modern Synthesis‹ to Cybernetics: Ivan Ivanovich Schmalhausen (1884–1963) and his Research Program for a Synthesis of Evolutionary and Developmental Biology«, in: *Journal of Experimental Zoology* 306 B (2006), pp. 89–106, here p. 101.

33 See Paul E. Lydoph: »Soviet Work and Writing in Climatology«, in: *Soviet Geography: Review and Translation* 7 (1971), no. 10, pp. 637–661. Jonathan D. Oldfield: »Climate Modification and Climate Change Debates Among Soviet Physical Geographers, 1940s–1960s«, in: *Advanced Physical Review* 4 (2013), pp. 513–521.

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Post-Soviet ecological research features two tendencies: the adoption of Western terminology in favor of a more profound connectivity to the Anglophone academic discourse and the insistence on one's own scientific tradition. Comparing the changes in the use of the notions of ecosystem and biogeocoenosis, Sergei Ostroumov attempted to redefine biogeocoenosis:

»Biogeocenosis is an aggregate of natural components (atmosphere, rocks, plants, animals, representatives of microorganisms and fungi, soil and hydrological conditions, and bottom sediments in the case of aquatic systems) in a particular area of land or water. Biogeocenosis is characterized by specific relationships between components; specific types of matter, energy, and information flows providing a certain degree of integrity (unity of components, indivisibility) and their changes with time. Organisms usually contribute to environment formation or modification«.[34]

Other definitions can be traced back to Sukachev's explanation: »The concept of an ecosystem is abstract, that is, it is not tied to a specific area, unlike a biogeocoenosis, which is usually tied to a concrete territory«.[35] In this case, BGC is also equated to ›landshaft‹ or a geographical version of the ecosystem. Currently, Russia experiences a tendency which aims to strengthen and valorize Soviet terminology.[36] Towards the end of the 20th century, the term biogeocoenesis was also broadly used in post-Soviet states. The beginning of the 21st century saw a recognition of the positive achievements of Soviet ecology and environmentalism as well as a revival of ecological culture, which empathizes with its ›green‹ tradition while also being politically reflective and critical of ecocide. This is also part of the legacy of Sukachev's teachings on biogeocoenosis.

34 S[ergei] A. Ostroumov: »New Definitions of the Concepts and Terms Ecosystem and Biogeocenosis«, in: *Doklady Akademii Nauk (Biological Sciences)* 383 (2002), pp. 141–143.

35 U[mar] T. Gairabekov et. al.: *Slovar' Geoėkologicheskikh terminov i ponatii. Uchebnoe posobie* (Dictionary of Geoecological Terms and Concepts. Study Guide), Groznyi: Izd-vo. ChGU 2015, p. 397: »Понятие экосистемы абстрактное, то есть не привязано к какому-либо конкретному участку территории, в отличие от биогеоценоза, который обычно привязан к какой-либо конкретной территории«.

36 See Ė[duard] N. Mirzoian: *Stabovlenie ėkologicheskikh koncepcii v SSSR. Biogeotsenologiia V. N. Sukacheva* (The Formation of Ecological Concepts in the USSR. V. N. Sukachev's Biogeocoenology), Moscow: Lenand 2016.