SCIENTIFIC HERITAGE (НАУЧНОЕ НАСЛЕДИЕ)

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SCIENTIFIC HERITAGE OF PROFESSOR AKIRA OSAWA

O. A. Zyryanova

V. N. Sukachev Institute of Forest, Russian Academy of Sciences, Siberian Branch
Federal Research Center Krasnoyarsk Scientific Center, Russian Academy of Sciences, Siberian Branch
Akademgorodok, 50/28, Krasnoyarsk, 660036 Russian Federation

E-mail: zyryanova-oa@ksc.krasn.ru

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The article includes a biographical essay of Professor Akira Osawa (Japan) and a brief analysis of his scientific legacy. A. Osawa was born and raised in the post-war period, which became the period of the formation of a sovereign Japanese state and its tremendous economic growth (Japanese economic miracle). He was educated and received a Doctor of Philosophy Degree at the prestigious Yale University (USA), where he gained the first experience of an international scientific cooperation. Knowledge in the fields of general and forest ecology, forestry and environmental protection A. Osawa successfully applied carrying out research projects, preparing his articles and books, reviewing manuscripts of the other authors as well as teaching university and postgraduate students and conducting international environmental assessments of the Japanese Government. His scientific research was focused on self-thinning phenomenon, stand growth and development, natural catastrophic disturbances and their consequences, and ecosystem carbon dynamics. Boreal forests in North America, Siberia and Scandinavia have been the major subjects of his studies. The main achievement of A. Osawa's investigations was the new method proposed for quantitatively (stand density and stem parameters) reconstructing structural development over time of even-aged monospecific forests and applied to a larch (*Larix gmelinii* (Rupr.) Rupr.) stand in the permafrost zone of Siberia. It relies on samples obtained from one-time observation that is of great importance for vast Siberian territories. Akira Osawa was the author and co-author of many scientific articles and chapters of monographs published in leading world journals and publishing houses, an active member of professional scientific communities and organizations. A. Osawa's biographical data were listed in Marquis Who's Who in the World (1995). The article contains a list of his main scientific publications, which gives an idea of the research topics, their geography and significance.

Keywords: *Akira Osawa, 1954–2019, short biography, forest ecology, forestry, even-aged larch stands, reconstructing structural development of tree stands.*

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INTRODUCTION

Human memory is selective, and it is constantly freed from unnecessary information. However, some moments are remembered for a long time, sometimes for a lifetime.

Early morning of May 23rd, 2019, was cloudy, and I put the umbrella into my bag not to get wet. In my room at the Institute I switched on PC and checked my post box. Not finding something important or urgent I turned to the usual routine, because many official formalities were expected to be done before our joint Russian-Japanese field research planned at Tura Experimental Forest and in the southern part of Krasnoyarsk region.

Sharp short sound made me to pay attention to the monitor where I saw the letter from Dr. Yojiro Matsuura with the phrase in the theme line: «He has

Fig. 1. Professor Akira Osawa.

just gone». This was very sad information on the decease of Professor Akira Osawa. And I heard the increasing noise of the rain outside: Siberian nature was crying together with me.

The first impression. I first met Dr. Akira Osawa in September 1995. He was one of four Japanese scientists coming to Krasnoyarsk to discuss the possibilities of Russian-Japanese cooperation focusing on the dynamics and productivity of Siberian forests. He stood out among his colleagues with a deep scientific curiosity, inquisitiveness, liveliness of mind and readiness to adopting new as well as by a critical thinking and objective analysis. Russian scientists also were affected by his fluent and running English, and only later on could we understand the reason of such perfect language knowledge.

Biographical events: education, honors, academic and professional experience, employment. Akira Osawa (Fig. 1) born on 19 April, 1954, in the city of Saitama – the center of Saitama Prefecture – located around 100 km northward of Tokyo.

The region is characterized by being one of the highly populated territories in Japan with average density of 5752 inhabitants per square kilometer.

In 1978 he has graduated from Nagoya University (Aichi Prefecture, Japan) with Bachelor of Science degree in Forestry. This four-year schedule in Laboratory of forest Environment and Resources of Department of Bioenvironmental Sciences (School of Agricultural Sciences in Graduate School of Bioagricultural Sciences) was the first of A. Osawa's knowledge in forestry science.

For his further professional education he decided to move to the USA and went there as a winner (1978) of the Overseas Student Exchange Scholarship (Ministry of Education, Japanese Government). In 1978–1979 as a special foreign exchange student, A. Osawa attended the living-learning programs of Oberlin College (Oberlin city, Ohio, USA). The Ecosystem Ecology course (Environmental Studies Department) in the College was the most tailored to his major and his interests. Here the student A. Osawa first learned the ecosystem concept, which provides a framework for understanding complex interactions between life and the physical environment and the role of humans as dominant agents of biogeochemical change. In this course, he studied the systems concepts to understand the flows of energy and the cycles of matter and control mechanisms that operate in ecosystems. Through group projects with his classmates, A. Osawa was comparing the structure and function of a variety of natural and human-dominated ecosystems all over the world enhancing and enriching in class instruction with focused out-of-class learning experiences.

Next (1979) year A. Osawa, as a Cornell University Research Assistantship, moved to the city of Ithaca, the state of New York, to continue his professional education. In 1981 he graduated from Department of Biological and Environmental Engineering in the College of Agricultural and Life Sciences of the Cornell University with Master of Science degree in Environmental Engineering, minor in ecology and evolutionary biology. The theme of Osawa's investigations and M.S. Thesis was «A mathematical model of the phenology of vegetative bud development in balsam fir». His major professor and supervisor was Dr. C. A. Shoemaker. In 1983, based on the thesis data, A. Osawa (with the co-authors C. A. Shoemaker & J. R. Stedinger) published his first paper in a refereed journal (see list of publications).

In 1981 A. Osawa changed Ithaca-city for the city of New Haven in the state of Connecticut (USA). Yale University, which the main commitment and mission statement is embodied in «improving the world today and for future generations», is located in New Haven-city. Akira Osawa stayed there in the period from 1981 till 1986. He started his research as a recipient of Yale University Fellowship and continued his investigations as a recipient of Romill Foundation Fellowship in 1984. Osawa's studies concerned to the dark-coniferous forest dynamics in the northeast of the USA and resulted in his Ph.D. Dissertation titled "Patch dynamics of spruce-fir forests during a spruce budworm outbreak in Maine'. His major professor and supervisor at the University was Dr. David M. Smith. After the dissertation defense Akira Osawa got the Degree of Doctor of Philosophy in silviculture and forest ecology.

In April 1986, newly minted Dr. A. Osawa moved to the College of Forest Resources (at the present time – College of the Environment) at the University of Washington (Seattle, Washington). Here he was involved in a project in the Stand Management Cooperative, studying branch dynamics in Douglas-fir plantations. He also conducted projects on consideration of the self-thinning rule in tree populations. In the study Dr. Osawa was associated with Drs. Chadwick D. Oliver and Douglas A. Maguire.

In December 1987, as a visiting scientist of Forest Research Institute in the city of Christchurch, New Zealand, Akira Osawa investigated the self-thinning relationship of natural mountain beech (*Nothofagus solandri* Poole) populations at Craigieburn Forest Park in central South Island of New Zealand. The project of New Zealand's Ministry of Forestry, where A. Osawa was participating and getting his first experience in the international joint research cooperation, was hosted by Drs. U. Benecke and G. H. Stewart, the specialists in black beech tree stand study.

In the period April 1988 – March 1996 Dr. A. Osawa was working as a silviculturist for the Hokkaido Research Center of the Forestry and Forest Products Research Institute (Ministry of Agriculture, Forestry and Fisheries) in the city of Sapporo (Hokkaido Prefecture, Japan). Here he conducted studies on stem form development, its relationship to plant self-thinning, and effects of natural disturbances on patterns of stand development. That time (in autumn of 1995) A. Osawa first visited V. N. Sukachev Institute of Forest to learn the possibilities for Japanese-Russian mutual cooperation.

From April 1996 till March 2006 Dr. A. Osawa was working for Ryukoku University (Ohtsu, Japan), first (April 1996 – March 2001) as an associate professor of Faculty of Intercultural Communication. He taught undergraduate and Master's level students in several environmental subjects, including «Global environment and humanity», «Environmental conservation», «Global resources», «Natural environment and industry». From April 2001, when in addition to other courses he instructed in English language «Introduction to natural environment», Dr. A. Osawa became a professor of this Faculty. In the period April 2004 – March 2006 professor A. Osawa was also acting as a Dean of Graduate School of Intercultural Communication Faculty in Ryukoku University.

From August 2006 until his illness, Professor A. Osawa was working for Graduate School of Global Environmental Studies and Graduate School of Agriculture, Division of Forest and Biomaterials Sciences in Kyoto University (Kyoto Prefecture, Japan).

OTHER RESEARCH ACTIVITIES

After 1991, despite the main employment, Akira Osawa was involved in various research activities. In April 1991 A. Osawa, as a silviculture specialist and advisor, was invited to participate in an official mission of the Japanese Government to Brazil that examined feasibility of aiding a plantation project of slash pine *Pinus elliottii* Engelm. in the State of Sao Paulo. Mr. Y. Utsuki of Japan International Cooperation Agency (JICA) was the mission leader. In September-November 1995, as a visiting scientist, A. Osawa was invited to the Department of Forest Resources (University of Maine, Orono, Maine, U.S.A), to examine the relationship of the number of tree rings in sapwood cross-section vs. tree age in balsam fir *Abies balsamea* (L.) Mill. Dr. D. A. Maguire has hosted this visit. In the period from 1991 till 2019, Akira Osawa was acting as a principal investigator in the Ecological study of jack pine forests in Northwest Territories, Canada. He initiated and conducted studies on structural development of jack pine *Pinus banksiana* Lamb. populations in Wood Buffalo National Park. Later, in April 2002 – March 2003, A. Osawa, as a visiting professor (Department of Renewable Resources, University of Alberta, Edmonton, Alberta, Canada), continued his research in this Park. He conducted a study on carbon budget of jack pine forests by examining biomass increment, organic litter and heterotrophic soil respiration in several even-aged stands.

SIBERIAN RESEARCH: A NEW METHOD AND ITS APPLICATION

At the same time Dr. Osawa spread his scientific interests to the boreal forests of Eurasia. In 1992 he started his research in larch forests in Yakutia, in 1995, after the inspection of the forested areas in Evenkia, he decided to continue his larch forest studies in this part of Siberia (Fig. 2–5).

Fig. 2. Discussion on larch stand development and tree differentiation in permafrost forest in Evenkia.

Fig. 3. To get remote area in Evenkia we could by helicopter only: one of the trips to Putorana mountains in Central Siberia.

Fig. 4. Looking for suitable experimental plots: a travel by a boat on Nizhnyaya Tunguska is the best way to observe huge postfire areas.

Fig. 5. The final photo at the end of the joint Russian-Japanese field studies at Evenkia Experimental station, in the settlement of Tura.

The main goals of his investigations here were the examination of structural development, carbon budget, and nutrient dynamics of the Central Siberian larch *Larix sibirica* Ledeb. forests.

In an integrated study on carbon dynamics of Siberian larch stands, Dr. A. Osawa developed a new method for reconstructing stand structure, which has been currently extended for estimating carbon dynamics in the past. The role of soil nitrogen on structure and development of larch forests was also studied.

A method was proposed for quantitatively reconstructing structural development over time of even-aged monospecific forests. It relies on samples obtained at one-time observation and some simple assumptions considered general in even-aged stands. Tree-ring data taken from breast height of a group of the largest trees and those measured at various stem heights of several individuals representing the range of tree sizes in the plot are used for the estimation. Stand density and parameters of stem volume distribution at a given time in the past were calculated with the «stem slenderness index», and with an assumption of the –3/2 power distribution for the distribution function of stem size, respectively. By developing time-dependent allometric relationships for individual tree attributes, the whole-stand values of stem volume and its increment were reconstructed for several decades of stand development.

The data required for the proposed stand reconstruction and the calculation of relationships and variables are summarized in the following:

Required data

(1) In various even-aged stands in the study area, DBH (*d*) and tree height (*h*) for several individuals are measured.

(2) In the same stands as above, stand density (number of trees per hectare; *N*) and maximum tree height (*H*) are measured.

(3) In a stand of which past structure is to be reconstructed and for several selected trees of various sizes (including the largest), DBH (*d*(*t*)), tree height (*h* (*t*)), total stem volume (*w*(*t*)), and annual stem volume growth (*x*(*t*)) for a given year (*t*) that are measured with stem analysis are obtained.

(4) In the reconstruction plot, DBH (*d*(*t*)) of the largest *n** trees for a given year (*t*) in the past are determined. The data may be obtained either by extracting stem cores or cutting out stem discs.

Calculation of relationships or values

(1) Using d and h data of a given stand (from step 1), establish the allometric relationship of equation $h = cd^{b_3/a_3}$, and determine the stand-specific stem slenderness index (*c*).

(2) Using N and H data and the calculated stem slenderness index (*c*) of various stands (from steps 2 and 5), express stand density (*N*) as a function of *c* and *H* $\left(N = \dfrac{e^{1.72c}}{1.08H^2} \right)$.

(3) Using (*d*(*t*)) and (*h*(*t*) data (from step 3), establish an allometric relationship of equation $h = cd^{b_3/a_3}$ and determine the stem slenderness index (*c*(*t*)) of that year.

(4) Assuming that *h*(*t*) of the largest sample tree representing the maximum tree height of the stand at year *t* (*H*(*t*)) (from step 3), and using the results of steps 6 and 7, calculate the stand density of year *t* (*N*(*t*)) as a function of *c*(*t*) and *H*(*t*).

(5) Using *d*(*t*), *w*(*t*), and *x*(*t*) data (from step 3), establish the allometric relationships between *w*(*t*) and *d*(*t*), and between *x*(*t*) and *w*(*t*).

(6) Using *d*(*t*) data of the largest *n** trees (from step 4), calculate *w*(*t*) of these trees with the obtained *w*(*t*)–*d*(*t*) allometry (from step 9). Then, calculate *Y*(*w*) $\left(Y(w) = \int_w^{w_{\max}} \varphi w(w) dw \right)$ and $\left(M(w) = \dfrac{Y(w)}{N(w)} \right)$ for all sizes of *w*. These *Y*(*w*) and *M*(*w*) values are then used to estimate the parameters *A* and *B* of the –3/2 power distribution (φ(*w*)) in equation $\varphi(w) = \dfrac{\sqrt{B}}{2A} w^{-3/2}$ for year *t*.

(7) Determine the minimum tree size ($w_{\min}$), by truncating the estimated stem size distribution (φ(*w*); from step 10) so that the cumulative stem number (adding in descending order from the largest) equals the calculated stand density (*N*(*t*); from step 8).

(8) Using $w_{\min}$ (from step 11), calculate values of total and mean stem volume as $Y(w_{\min})$ and $M(w_{\min})$, respectively, with the equations from step (10). Then, with the *x*(*t*)0–*w*(*t*) allometry (from step 9) and $\left(X = \int_{w_{\min}}^{\mathrm{mathbf}w_{\max}} x(w) \varphi(w) dw \right)$, calculate the total value of the annual stem volume growth ($X(w_{\min})$).

The method elaborated was successfully applied to a larch (*Larix gmelinii* (Rupr.) Rupr.) forest in Central Evenkia, Krasnoyarsk region. Estimated history of the changes in stand density, total stem volume, and stem volume growth for the dense larch stand examined, mostly agreed with a separate estimation by the self-thinning assumption.

Japanese-Russian research projects. Professor Akira Osawa was a leader, co-leader and co-investigator of numerous Japanese-Russian joint research projects. Here are the titles only several of them:

– «Integrated study for terrestrial carbon management of Asia in the 21st century based on scientific advancements (sponsored by Ministry of Environment, Japan)» (2003–2006, V. N. Sukachev Institute of Forest RAS (SIF RAS) – Forestry and Forest Products Research Institute (FFPRI));

– «Estimation for carbon storage and carbon sequestration in northern forest ecosystem in Russia» (sponsored by Ministry of Environment, Japan) (2007–2010, SIF RAS – FFPRI);

– «Advancement of East Asia Forest Dynamics Plot Network – Monitoring forest carbon cycling for the development of climate change adaptations» (2014–2018, SIF RAS – FFPRI);

– «Structural changes in circumpolar boreal forests and climate change: analysis for the past 150 years with the stand reconstruction technique» (2014–2017, SIF RAS – Kyoto University), etc. (Fig. 2–5).

The results of ecological research on Siberian larch forests that has been conducted jointly by a team of Russian and Japanese scientists in northern part of boreal Siberian forests have been summarized in the monograph: Osawa A., Zyryanova O. A., Matsuura Y., Kajimoto T., Wein R. W. (Eds.) (2010). Permafrost Ecosystems: Siberian Larch Forests. Ecological Studies Series, Springer, Dordrecht. 502 p.

Membership in professional societies and editorial boards. Dr. A. Osawa was a member of a number of professional societies: Ecological Society of Japan, Japanese Forestry Society, Botanical Society of Japan, Ecological Society of America, Society of American Foresters, New York Academy of Sciences, Sigma Xi Scientific Research Society, Ryukoku University Society of Intercultural Communication.

Being an advanced and experienced scientist, Professor A. Osawa served as a reviewer and a member of the editorial boards for professional journals such as American Naturalist, Annals of Botany, Canadian Journal of Forest Research, Ecology, Ecological Research (Associate editor, Sept. 2000 – Sept. 2003), Ecoscience, Eurasian Journal of Forest Research (Review board, 1999–2019), Forest Ecology and Management, Journal of Ecology, Journal of Forest Research, Journal of Sustainable Forestry, Journal of Tropical Ecology, Tree Physiology.

Created a scientific family. Akira Osawa started a scientific family. His wife, Nahoko Kurachi-Osawa, was working for Hiraoka Forest Institute. She was his real collaborator during their research in Northwestern Canadian forests and a co-author of many Osawa's articles. Their daughter Hatena decided to follow the path of her parents. Like her father, Hatena was a student of Nagoya University. She was studying there her Master's program in paleontology having interest in evolution and ecology of old invertebrates that lived about five billion years ago. Hatena's research site was in Mongolia and she visited there twice a year collecting rocks and fossils including the areas around Lake Khubsugul just across the border from Russia. A. Osawa wrote in one of his letters: «I understand that she is using some devices over there preparing the rock samples for examination. It has turned out that Hatena is quite adaptable to the field conditions in Mongolia even if she does not look so strong. It may be a result of her experience spending substantial time in the forest every year with her parents in northern Canada». Professor A. Osawa has proud of his family and of his daughter especially.

CONCLUSION

Undoubtedly, Professor Akira Osawa was an outstanding world-famous scientist. He devoted his life to the study of the forests in various parts of our planet, giving preference to the investigations in boreal forests. He liked Siberian nature and the northern Siberian larch forests, which opened the peculiarities and the regularities of their development to him. He has left rich scientific legacy that has yet to be explored.

The bright memory of you forever, Osawa-san!

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НАУЧНОЕ НАСЛЕДИЕ ПРОФЕССОРА АКИРЫ ОСАВЫ

О. А. Зырянова

Институт леса им. В. Н. Сукачева СО РАН – обособленное подразделение ФИЦ КНЦ СО РАН
660036, Красноярск, Академгородок, 50/28

E-mail: zyryanova-oa@ksc.krasn.ru

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Статья включает биографический очерк профессора Акиры Осава (Япония) и краткий анализ его научного наследия. А. Осава родился и вырос в послевоенное время, ставшего периодом становления государства Япония и его грандиозного экономического роста (японского экономического чуда). Он получил высшее образование и степень доктора философии в престижном Йельском Университете (США), где приобрел первый опыт международного научного сотрудничества. Свои знания в области общей и лесной экологии, лесоведения и охраны окружающей среды А. Осава успешно применял при выполнении исследовательских проектов, подготовке своих статей и книг, рецензировании рукописей других авторов, в процессе обучения студентов университетов и аспирантов, при проведении международных экологических экспертиз Правительства Японии. В фокусе его научных интересов – феномен самоизреживания древостоев, их рост и развитие, катастрофические нарушения природных экосистем и их последствия, динамика углерода в лесных экосистемах. Объектами исследований были бореальные леса Северной Америки, Сибири и Скандинавии. Основным достижением научных исследований А. Осавы стал метод реконструкции со временем структуры древостоев (густота древостоя и параметры стволов деревьев), разработанный и примененный для одновозрастных одновидовых лиственничных насаждений (*Larix gmelinii* (Rupr.) Rupr.) в криолитозоне Сибири. Главное преимущество метода заключается в одноразовом сборе полевых материалов, что важно для Сибири с ее обширными территориями. А. Осава – автор и соавтор многих научных статей и глав монографий, опубликованных в ведущих мировых журналах и издательствах, активный член профессиональных научных сообществ и организаций. Биографические данные А. Осава упомянуты в справочном издании Marquis Who's Who in the World (1995). В статье приведен список его основных научных трудов, который дает представление о тематике исследований, их географии и значимости.

Ключевые слова: *Акира Осава, 1954–2019, краткая биография, лесная экология, лесное хозяйство, одновозрастные лиственничные насаждения, реконструкция структурного развития древостоев.*

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