SLOVAK ETHNOLOGY NÁRODOPIS SLOVENSKÝ
2 64 • 2016
ARTICLES

THE CONTRIBUTION OF JOSIP BAKIĆ'S RESEARCH TO THE STUDY OF WILD EDIBLE PLANTS OF THE ADRIATIC COAST: A MILITARY PROJECT WITH ETHNOBIOLOGICAL AND ANTHROPOLOGICAL IMPLICATIONS

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Between 1962-1986 the Yugoslav Army carried out a project in which Josip Bakić from the Institute for Naval Medicine of the Yugoslav Navy in Split took the main professional role. In the project, amongst other activities, Bakić and his team explored the possibility of soldiers' survival on the Adriatic islands based on wild plants and marine animals. As a part of this project, wild food plants and animals from the coast that had been used by the population during World War I and II were surveyed. Some phytochemical properties of the plants were also studied. Education of soldiers and the wider public was provided based on the results of the research and experiments. The project is a unique example of combining a scientific study with a practical military experiment. Apart from scientific papers the results were also popularized as a survival handbook, a book about nutrition from nature, film documentaries, and workshops. In this paper we summarize the achievements of this project based on the review of published data and interviews with Josip Bakić.

Key words: foraging, famine, World War II, survival, wild edible plants, wild foods, sea food, Adriatic coast

INTRODUCTION

Hunting and gathering were once the only sources of food for humans. With the invention and development of agriculture their importance diminished. However, most rural human populations still gather food from the wild to some extent (Hedrick, 1919; Maurizio, 1927; Moszyński, 1929). Foraging, i.e. gathering wild food includes terrestrial plants, fungi and insects, as well as marine algae, molluscs, turtle eggs and other sea creatures. After years of gradual abandonment, foraging has now become a fashionable part of 21st century haute cuisine (Łuczaj et al., 2012). Paradoxically, in the 19th and 20th centuries it was seen as an occupation for the poor, which increased during times of bad crops and famine. The documentation of traditional foraging comes from

travelogues, old ethnographic papers and descriptions of famine, which has struck nearly every nation on Earth (Hedrick, 1919; Maurizio, 1927; Svanberg and Łuczaj, 2014). The plants used in times of shortage were usually those known as edible or at least safe and worthy of attention during famine. However, in times of dire starvation people ate even unfamiliar foods and often got poisoned by them. Sometimes local authorities tried to help people and published special leaflets explaining how to cope with famine and instructing farmers what to eat. This was the case for example in 19th century Sweden and Austro-Hungary, as well as during World War I in Germany and Austro-Hungary (Maurizio, 1927). In the latter case, the German army also tried to use wild plants to make tinned provisions for the soldiers. Awareness of the importance of foraging for soldiers is widespread among the military authorities, and training in obtaining such provisions is often provided, especially for the special forces. Unfortunately, such practices are usually shrouded in a veil of secrecy.

A unique case occurred in the former Yugoslavia, where one man played a major role in a military project that stretched over all the areas of study of wild foods: documentation of traditional knowledge of wild foods, studying their chemical composition, training the army and designing survival tactics, organizing survival expeditions and disseminating the results of the studies and experiments to the general public. This man is Josip Bakić.

MACRO-PROJECT "SURVIVAL IN NATURE"

Josip Bakić was born on the 2nd of March, 1935 in Split, and most of his career took place in this Dalmatian city. He graduated in Biology in the Natural Sciences and Mathematics Faculty of the University of Zagreb in 1960. As a part of his regular military service (1961–1962) Bakić served in the Hygienic Institute of the Main Military Hospital where he was given an assignment to search in the literature data on what had been eaten from nature in the past in the area of the Adriatic coast of former Yugoslavia. In 1962 he worked in the same Institute and in 1964 he moved to the newly established Institute for Naval Medicine of the Yugoslav Navy (Grabovac and Bakić, 2009). Actually, from the very beginning Bakić worked on the macro-project "Survival in Nature", which lasted for 24 years (1962 – 1986) and was initiated by Academic Gojko Nikoliš and Professor Borivoj Vračarić (Bakić et al., 1975). The idea behind this former Yugoslav Army Project was to study flora and fauna as an additional or the only source of food during food shortages, and to educate people so that they could survive a situation of natural catastrophe or war. Later, from 1966 on, Bakić was the author of all the concepts and designs of the experiments in the project.

The project had five main themes (Bakić et al., 1987) that were often intertwined: 1) an inventory of edible flora and fauna of the region with an evaluation of phytochemical and nutritional properties; 2) a series of biological experiments on soldiers' and ordinary people's survival on the Adriatic coast and islands based on wild plants and sea animals; 3) a survey of wild food plants and animals of the coast used by the local population (especially during World Wars I and II); 4) the preservation and use of wild food, and 5) the popularization and dissemination of the results. The projects were sponsored by KOMNIS – Komisija za medicinska istraživanja, that later became Savjet za naučna istraživanja oružanih snaga Jugoslavije (Committee for Medical Research of Armed Forces of Yugoslavia). In this paper we summarize the achievements

Fig. 1. The authors of the article interviewing Josip Bakić in 2015 (in the middle)

of the project based on the review of published data and a series of interviews with Josip Bakić performed in 2015 and 2016 (Fig. 1).

While performing military service, Bakić (1961) made a list of the edible flora and fauna of the Adriatic coast. During the period of 1962 – 1964 the edible flora and fauna enabling the survival of a small group of people were assessed at four locations that represented the vegetation of the whole Adriatic region from Slovenia to Montenegro. Also, using the same methodology, but survival experiments, the team led by Bakić analysed the flora and fauna of eight other locations (Bakić et al., 1975). In a publication by Bakić (1971), edible flora and fauna are presented in different seasons of the year. Methods of preparation and evaluation of carbohydrate content were given for 31 plant species, and protein content for 32 animal species. The average content of fats, proteins, carbohydrates and calories that each individual consumed for survival, calculated for all seven expeditions, is also presented. Interesting work was done during two survival camps in 1966 on the island of Pag and in 1969 on the island of Dugi Otok. By comparing the theoretical numbers of edible plants and animals (i.e. those recorded in the flora), with what was actually available to the participants, Bakić discovered that the group could utilize a much lesser number of plants and animals, taking into account the time of year and the size of plant populations (Ferber and Bakić, 1974). This comparison was performed during the first four survival activities (Fig. 2; Table 1; Bakić et al., 1975). The registering of edible wild flora and fauna was carried out from 1977 to 1980. During that period, edible species were recorded and mapped on seven islands (Cres, Lošinj, Molat, Vis, Korčula and Lastovo) and on Mount Biokovo (Bakić and Popović, 1990). The team would spend 14 days in every location in every season of the year except summer. As an example, the research transect for sampling edible vegetation on Lošinj was 80 km long. The team brought with them a portable laboratory, a technician and a chemist, Mira Škare ("she did a wonderful job", said Bakić; Bakić,

Fig. 2. Josip Bakić in 1962 (the man on the right), the first survival expedition on island Sveti Andrija

Tab. 1 The comparison of the number of edible taxa found in a few locations in Dalmatia with the number of taxa which could be actually utulized in the time of the expedition (from Bakić et al. 1975, modified).

Area	Edible Plants (all / available in a given season)	Edible Sea Animals (all / available in a given season)	Edible Terrestrial Animals (all / available in a given season)
Sv. Andrija (July)	28 / 15	17 / 10	14 / 5
Ščedro (October)	50 / 16	18 / 11	20 / 5
Ljubač (April)	75 / 26	44 / 21	19 / 4
Kornat (July)	57 / 18	36 / 15	21 / 3

personal communication). The plants gathered were analysed for vitamin C content and then prepared for further analyses in the main laboratory (Bakić et al., 1983). The plants were analysed for proteins, fats, carbohydrates, caloric value, water, cellulose and ashes. As an example, 41 plant species were studied from Biokovo, including three *Allium* species whose roots and leaves were studied separately (Bakić et al., 1983). Bakić and Škare (1994) analysed the amount of calcium in 79 species belonging to 35 families from seven locations. The leaves and roots of wild vegetables and wild fruits were analysed. They found out that the calcium content in wild edible plants significantly exceeds that of cultivated plants. During all expeditions data related to hunting and fishing by simple, primitive techniques, either learned from native people or invented during field trips, and simple methods of food preparation were recorded. This resulted in the description of 42 hunting and fishing devices and 80 drawings (Bakić et al., 1975).

In two papers (Bakić et al., 1987; Bakić, 2014), Bakić describes in detail a case of

poisoning with summer snowflake (*Leucojum aestivum* L.) during one of the survival activities on the mountain Dinara in 1980. As the team read in two books that *L. estivum* is edible after cooking, they decided to cook it and serve it for dinner as soup. The cook didn't follow the instructions of the biologist, didn't throw away the first water after 15 minutes of cooking, and cooked it for only 45 minutes. The group of 18 participants, including Bakić, had a bad reaction 5 to 10 minutes after the meal, paraesthesia of lips and fingers, intense pain and pressure in the chest, tachycardia, a sense of suffocation and strong vomiting 2–5 times per person. Half an hour after the meal they felt heaviness and pain in the stomach, had strong diarrhea and nausea, and flatulence during the whole night. This condition lasted for two days in spite of medical care and drinking medicinal teas. What Bakić emphasizes is the danger of consuming what he calls "conditionally edible plants", because they could cause serious threats to human health, especially in circumstances of hunger when the human organism is weak. Another case of poisoning during the activities of the project was poisoning by sea anemone (*Anemonia sulcata* (Pennant)) during a survival exercise on the island of Šćedro (near Hvar) when a doctor, a member of the team, ate *A. sulcata* which was not fried enough. He ate a lot of it, since it was delicious. During the night he vomited severely, and for six hours had nausea, a severe headache, low blood pressure, severe pain in the stomach, languor, spasms of the stomach muscles, heavy breathing, diarrhoea, ataxia with numbness of the limbs, aphonia, disorientation with hallucinations, and fear of death. After 12 hours these symptoms were mostly gone, but a sense of fear and insecurity, with disorientation and lost balance, remained for several months (Bakić, 1969; Bakić 2014).

Preliminary experiments on the survival of a small group of people on three small islands and in a bay for 15 days in springtime, summer, and autumn were implemented in 1962 and 1963. The locations for this experiment were chosen so that it represented the whole Adriatic region of the former Yugoslavia (Bakić et al., 1975). Since there was no harm to their health (there was a thorough check-up prior and after expeditions), another large biological survival experiment of two weeks on the island of Pag was realized in 1966, with 86 soldiers, under the name "Collective Survival". In 1969, two tactical drills called "Shipwreck and Survival I and II" were performed (Fig 3). People were woken up in the middle of the night and had to swim to the island. From the island of Kornat they had to swim back to the island Dugi Otok, where they had to get to the other end of the island (Dugi Otok means Long Island) while doing tactical operations and gathering food at the same time. This time the "individual survival" principle was implemented (Bakić et al., 1975; Bakić et al., 1987). The result of these experiments was new knowledge in the domain of survival, especially the adoption of the principle of "individual survival". In other words, individual self-supplying with food from the wild enables collective survival, and is better done individually or in pairs rather than in larger groups within which responsibility is diluted. Later (1983 – 1984), five shorter survival experiments took place, with smaller groups combined with some tactical operations at different localities.

Josip Bakić was the author and head of the project *The use of wild plants and animals in people's diet in the area of the coastal Socialist Federal Republic of Yugoslavia*, which was part of a macro-project and lasted from 1976 to 1979 (Bakić and Popović, 1983). The goal of this project was to determine unconventional food resources from nature in people's diet. Two-page long questionnaires were sent to 104 settlements across the whole area of the Yugoslavian Adriatic coast and the islands (all the way from Slovenia

Fig. 3. Sailors collecting Pinus halepensis shoots for tea in the "Shipwreck and Survival I" expedition in Kornat islands in 1969

to Montenegro) in 4200 households, which made up 3.4% of citizens (Bakić, 1999). The selection of households was made by the administration of each settlement, choosing mostly older citizens, preferably with experience of one or two wars. Josip Bakić designed another questionnaire in 1976, which was 103 pages long and included accurate black and white drawings with common and Latin names. It included 4 algae species, 144 plants, 80 sea animals (excluding fish), 9 small terrestrial animals (they assumed that the names of larger animals were not in doubt) and 3 eggs of sea birds. Question pages followed: *which birds or bird eggs did you eat?; which mammals did you eat?; which fish did you eat?,* and *which plants and animals did you eat*? At the bottom of every page there was a reminder to enter the folk name, the way of foraging or hunting, and the method of preparation (Bakić, 1976). Using this questionnaire, a tape-recorder and a small diaprojector, the team headed by Josip Bakić interviewed citizens in 80 locations (Bakić and Popović, 1983, 1984) (Fig. 4). In every location they interviewed 1–4 knowledgeable informants, mostly 60–80 year old women, because men were absent during the war (Bakić, personal communication). The most interesting and valuable results of the study were related to people's diets during the World War II., which are presented in the paper by Bakić and Popović (1983). In this paper they presented the percentage of households which used particular species of plants and animals during the war. The paper reports the 38 most commonly used plants (used in >30% households). The percentages of households utilizing unusual sea animals (excluding fish), the percentages of households that used large and small terrestrial animals, and birds are also presented in the article (Table 2). Unusual breads made from wild plants, nutritious concentrates, preservation of wild animal meat, unusual foods, and sea salt production during the war are presented in detail.

Table 2 Wild plants and animals eaten by coastal households of former Yugoslavia during World War II (Bakić and Popović, 1983)

Species	Part used (not given in the original text, inferred from our own field experiences)	% of households that used certain specie for food during World War II
Plants		
Asparagus acutifolius	very young shoots	93.8%
Taraxacum megalorrhizon	aerial parts	92.5%
Sonchus oleraceus	aerial parts	91.2%
Foeniculum vulgare	aerial parts	90.0%
Taraxacum officinale	aerial parts	90.0%
Allium ampeloprasum	whole plants	88.8%
Tamus communis	very young shoots	82.5%
Rubus dalmaticus	fruit	80.0%
Rosa agrestis	fruit	78.8%
Juniperus oxycedrus	fruit	78.7%
Diplotaxis tenuifolia	aerial parts	70.0%
Quercus ilex	fruit	68.7%
Chenopodium urbicum	aerial parts	66.2%
Cichorium intybus	aerial parts	66.2%
Beta vulgaris	aerial parts	62.5%
Celtis australis	fruit	61.2%
Arbutus unedo	fruit	61.2%
Leontodon tuberosus	aerial parts and roots	61.2%
Eruca sativa	aerial parts	60.0%
Pirus communis	fruit	60.0%
Tragopogon pratensis	aerial parts	58.7%
Crataegus monogyna	fruit	53.7%
Prunus spinosa	fruit	51.2%
Eryngium maritimum	fruit	51.2%
Lactuca perennis	aerial parts	48.7%
Daucus carota	aerial parts and roots	43.7%
Crithmum maritimum	aerial parts	42.8%
Crataegus oxyacantha	fruit	42.5%
Urtica pilulifera	aerial parts	40.0%
Cornus mas	fruit	38.7%
Silene vulgaris	aerial parts	37.5%
Paliurus spina-christi	immature fruits	37.5%
Ruscus aculeatus	very young shoots	36.2%
Arum italicum	tubers, specially prepared	32.5%
Cirsium arvense	aerial parts	31.2%
Mentha aquatica	aerial parts	30.0%
Sea animals (fish excluded)		
Monodonta turbinata		100%
Patella coerrulea		100%
Murex trunculus		96.4%

Pinna nobilis		84.0%
Maia squinado		80.3%
Mytilus galloprovincialis		80.3%
Eriphia spinifrons		78.6%
Maia verrucosa		73.2%
Haliotis lamellosa		73.2%
Cerithiumvulgutum		69. 6%
Arca noae		69.6%
Anemonia sulcata		66.0%
Delphinus delphis		62.5%
spondilus gaederopus		57.1%
Caretta caretta		50.0%
Paracentrotus lividus		44.6%
Pecten jacobaeus		35.7%
Microcos mussulcatus		35.7%
Holothuria tubulosa		21.4%
Terrestrial animals and birds		
Helix pomatia and *H. aspersum*		72.5%
Lepus auropaeus		60.0%
Erinaceus euroaeus		36.0%
Orytogalus cuniculus		30.0%
Males males		22.5%
Glis glis		22.5%
Vulpes vulpes		20.0%
Rana ridibunda		17.0%
Testudo hermanni and *T. graeca*		12.5%
Turdus merula		53. 7%
Passer domesticus		46.2%
Alactoris graeca		38.7%
Columbia livia		38.7%
Turdussp. (trashes)		36.2%
Phasianus colchicus		27.5%
Coturnix coturnix		21.2%
Streptopelia turtur and *S. decaocto*		20.2%
Corvus corone cornix		16.2%
Coccothraustes coccothraustes		16.2%
Larus sp.		16.2%
Mergus serrator		15.0%
Garrulus glandarius		13.7%
Pica pica		11.2%
Scolopax rusticola		11.2%
Falco sp.		8.7%
Apus apus		6.2%
eggs of *Larus sp.*		50.0%
eggs of *Sterna hirundo*		10.7%

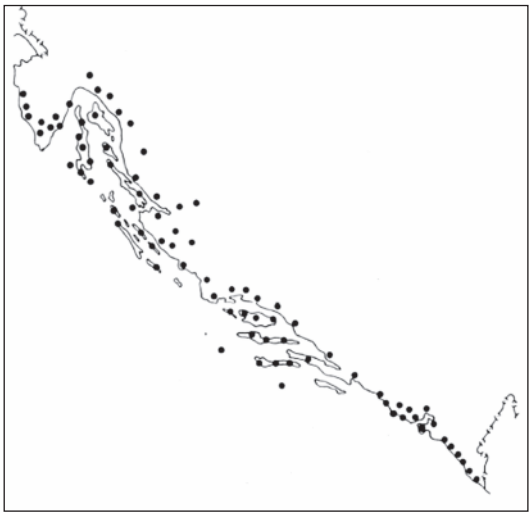

Fig. 4 The map of the 80 localities where interviews were performed

Unfortunately most of the original raw data are missing. Although the study had some disadvantages when regarded from the perspective of modern ethnobiological methodology, e.g. a questionnaire which pre-suggested the species, instead of asking the informants to free-list species, or the lack of voucher specimens, it is still a unique document recording the emergency foods of a population living on the Mediterranean. No documents like this exist in any European coastal country, including both wild plants and wild animals in the diet during wartime.

From 1981 to 1987, Bakić and members of the team researched and developed the preservation and processing techniques of some edible flora and fauna, which included the preservation of sea and fresh water species, making bread from some wild fruits, and the process of making fruit concentrates in improvised conditions (Bakić et al., 1980; Bakić et al. 1984; Bakić et al. 1986; Bakić and Popović, 1990).

The story of experiments on wild food based nutrition performed in biotopes characteristic of Dalmatia has also been documented in films. Radio Television Zagreb produced six 30 minute educational films on the concept of survival, filmed in biotopes characteristic of the east Adriatic coast. These films were "Survival on the uninhibited island "(1976), "Survival in the mountains" (1978), "Survival in the swamp" (1979), "Dinara 80" (1980), "Wild edible plants in tradition of Korčula" (1981), and "Food from the platter of the sea and the coast" (1982). The experiences were also used to make a popular guide *Mornar na pustom otoku* (*Sailor on an empty island*) (Popović and Bakić, 1979). Bakić was also the co-author of the book *Ishrana u prirodi* (*Nutrition in the Nature*) that was published in at least four editions (Vračarić et al., 1977). The above mentioned works have an educational character, as in his lecture at the First Conference of Croatian Biologists Bakić (1981) emphasised the need to bring the topic of unconventional food into the education system.

Josip Bakić stopped working with wild edible plants and animals in 1990, but his two later publications about use of wild food in the Neolithic (Bakić, 2001a, 2001b) are worth mentioning.

It must be emphasized that the *Survival in Nature* project, in which Bakić had a major professional role, is the only example in history in which military experiments on foraging were documented to such an extent and over such a long period of time, with the results made available to the public.

ACKNOWLEDGEMENTS

The research was financed by funds from the Ministry of Science and Higher Education, the National Science Centre in Poland [2015/19/B/HS3/00471].

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