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The Science at Croatian Universities: a Gloomy View through SCIsearch and MEDLINE*

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Aim. Comparison of scientific articles published during the last 10 years by scientists working at the universities of Zagreb, Rijeka, Osijek and Split (Croatia), Ulm (Germany) and Graz (Austria).

Method. Analysis of the numbers of papers obtained by searching the SCIsearch database of the Institute for Scientific Information (ISI) and MEDLINE.

Results. The universities of Osijek, Rijeka and Split, with only 0.42, 0.55 and 0.75 published papers per scientist over a 10-year period respectively, were found to have the lowest scientific output. Although the 1.65 papers published by an average scientist of the University of Zagreb were a significantly higher output compared with the above regional universities, they were still considerably below the production of the University of Ulm (6.6 papers per scientist) and that of Graz (2 papers per scientist). The comparison of the number of papers per 1,000 students gave similar results..

Conclusion. Irrespective of the parameter used for the comparison of scientific development, the three Croatian regional universities were found to lag significantly behind the University of Zagreb. In our opinion, the level of research activities is so dramatically low that it questions further development of these universities. The two main obstacles to an immediate improvement of Croatian science are: (a) a lack of high-quality scientists who could take up the burden of scientific development, and (b) a slow process of the organizational transformation of universities, with an obvious tendency to be devaluated since its very beginning. What Croatian scientific research urgently needs is the introduction of international standards, including the selection of scientists. The new Bill of Science and the National Research Program may be a good foundation for such efforts in the future.

Key words: Croatia; publishing; science; universities

Knowledge is a prime mover not only for economic and cultural progress, but of development in general. As has been widely recognized, research activity is of strategic importance for every country. Unfortunately, the long-lasting negative selection of scientists and neglect of the criteria proposed by the international scientific community have resulted in the present depressing situation in Croatian science (1). The fact is particularly striking at small universities, which have never reached the turning point required for an independent scientific output. Aspirations to obtain certificates, ranks and rewards have not been accompanied by corresponding scientific results. Criticisms of such behavior lack any real impact because the creators of this ethical framework have themselves been promoted according to their own criteria and the publication of their papers in low quality journals mostly serving the purpose of their authors promotion. The universal argu-

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ment that a weak science is of no avail, and therefore no science, seems never to have taken root among such scientists.

This paper documents the poor scientific development in Croatia whit emphasis on the very difficult situation at our regional universities. Rather than survey the various aspects of Croatian science at universities, this work concentrated on the publications indexed by Institute for Scientific Information (ISI) and MEDLINE.

METHODS

The assessment of research output can be carried out using various criteria, such as the number of papers published in first class journals, overall number of papers, number of active scientists, number and size of scientific institutions, investments in research and development, quality of infrastructure and equipment, etc. The one criterium applied in this study was the number of papers published in peer-reviewed journals indexed in the world-wide accepted bases and accessible to the international scientific community. Thus, the prime criterion depended on the accessibility of scientific work, rather than other aspects of the quality of journals in which the papers were published.

To evaluate the current status of scientific development of Croatian universities, we compared the numbers of their published papers obtained from the Science Citation Index (SCIsearch) database of the Institute for Scientific Information (ISI), and MEDLINE. The SCIsearch database is subdivided in 247 bases of scientific-disciplines in natural sciences and mathematics, biomedical sciences, biotechnology, technical sciences, informatics, social sciences, law, language and linguistics, history, music, art and humanities in general - listing articles from roughly 4,400 journals. On the other hand, MEDLINE is specialized in biomedical literature and covers 3,700 journals and approximately 22,000 books and monographs. In regard to the medical science the SCIsearch covers many sources identical with those of MEDLINE, but the latter lists in addition a number of biomedical publications that are not included in the SCIsearch - a difference not relevant for the comparative study. The search into these databases was carried out at the University of Ulm and financed by Dr. Thomas Mertens from the Institute of Microbiology. In recovering the data on the number of publications for the particular university, the name of a university was used as the search word in the address field. However, some of the papers published under the name of university may have been written by authors working at the institutions that are actually not affiliated to it. To restrict the data on the medical publications only, the searching terms "medical faculty" or "school of medicine" were used in addition of the names of cities and universities. For comparison, the University of Ulm and the University of Graz were included in the study.

RESULTS

Publications Included in the SCIsearch Database

The number of papers listed in the SCIsearch database was analized for the last 10 years, 1986 - 1995. (Table 1). Comparison of the total number of indexed papers from the universities of Rijeka, Split and Osijek on the one hand, with the number of those at the University of Zagreb, on the other hand, showed that regional universities significantly lagged behind, more than could be reasonably expected considering their size. The size of university was assessed by two parameters: the average number of students during academic year and the average number of registered scientists (2). The initially observed discrepancy in the number of published papers was significant when either of two criteria was applied: number of published papers per scientist, or number of papers per 1,000 students (Figs. 1 and 2).

An output lower than one paper per scientist over a 10-year period is a strong evidence of the lack of competitive science at Croatian regional universities, among which the University of Osijek is in the worst position, with only 0.42 papers per scientist, preceded by the Universities of Rijeka (0.55) and Split (0.75). An average scientist of the Universities of Zagreb published 1.65 papers in the same period - an output nevertheless disappointingly behind that of the University of Ulm (6.6 papers per scientist).

The comparison based on the number of papers published per 1,000 students in 10 years, the other parameter used to assess the size of a university, proved even more unfavourable for the regional universities (Fig. 2). It should be noted that the University of Ulm is of a size comparable to that of our regional universities, and yet it produces almost a 100 times more publications.

On the whole, these results confirmed our initial fear that the current status of research at Croatian regional universities has not reached the level required for further development. The structure of the listed papers and the quality-ranking of

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Table 1. Number of publications by university scientists listed in SCIsearch database in a 10-year period (1986-1995)

Year	Zagreb	Rijeka	Split	Osijek	Ulm	Graz
1986	549	12	14	5	985	688
1987	569	13	18	5	1,082	707
1988	580	11	15	10	1,102	696
1989	575	25	27	10	978	634
1990	652	36	37	14	924	718
1991	707	26	35	14	961	737
1992	702	39	23	14	1,126	753
1993	808	14	48	22	1,303	839
1994	729	29	45	18	1,295	980
1995	391	12	32	13	706	490
Total	6,262	217	294	135	10,471	7,242

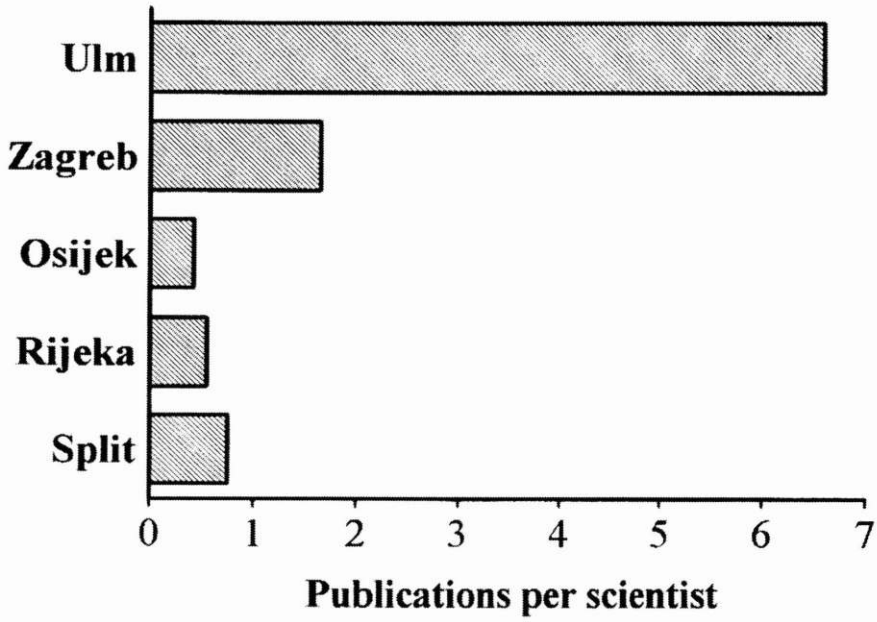

FIGURE 1.

Number of publications per scientist in a 10-year period (1986-1995). The total number of publications shown in Table 1 was divided by the number of scientists currently affiliated to the respective university (Ulm - 1,586; Zagreb - 3,814; Osijek - 318; Rijeka - 389; Split - 389). The data for the University of Ulm were obtained from the University authorities and the data for Croatian universities from the report Ministry of Science and Technology (2).

journals they were published in would undoubtedly be even more to our disadvantage, but they were not the subject of this paper.

Biomedical Publications Listed in the SCIsearch Database

A significant part of the publications listed in the SCIsearch database (Table 1) were published by scientists working at medical schools (Fig. 3). Almost a third of all the ISI-indexed papers from the University of Zagreb and nearly 50% of those from the University of Rijeka were published by the scientists of the respective Medical School. According to the findings obtained for the whole University, the Zagreb Medical School had a significantly higher scientific output than the Rijeka Medical School, a representative of regional universities that had been established 40 years ago. Although the Medical School at the University of Split functions as a branch of the Zagreb Medical School, its scientific output was comparable to that of the Medical Faculty in Rijeka. This fact indicated that the existence of traditional medical schools is not a necessary condition for the development of research. The data presented in Fig. 3 suggest that biomedical research in Croatia, albeit underdeveloped in comparison to European universities, still represents one of the leading disciplines in Croatian science (2,3).

Biomedical Publications in MEDLINE

To evaluate the status of biomedical research at Croatian regional universities, we compared the papers registered by MEDLINE during a period

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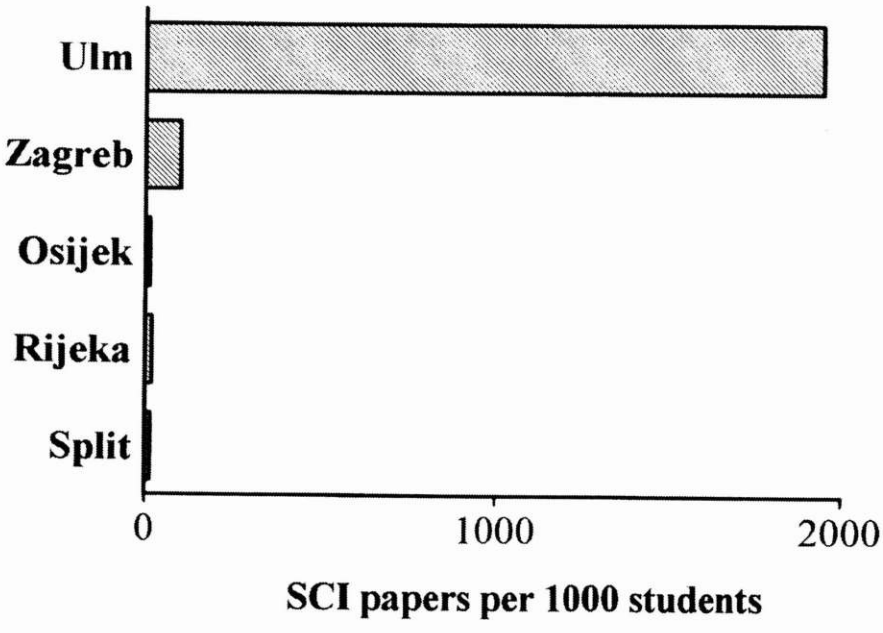

FIGURE 2.

Publishing activity correlated with the size (1,000 students) of Croatian universities in a 10-year period (1986-1995). The total number of publications shown in Table 1 was divided with the number of full-time students at a university during the school year 1994/95 (Ulm - 5,000; Zagreb - 48,500; Osijek - 6,000; Rijeka - 8,200; Split - 9,800). The data for the University of Ulm were obtained from the University authorities and the data for the Croatian universities from the report of the Ministry of Science and Technology (2).

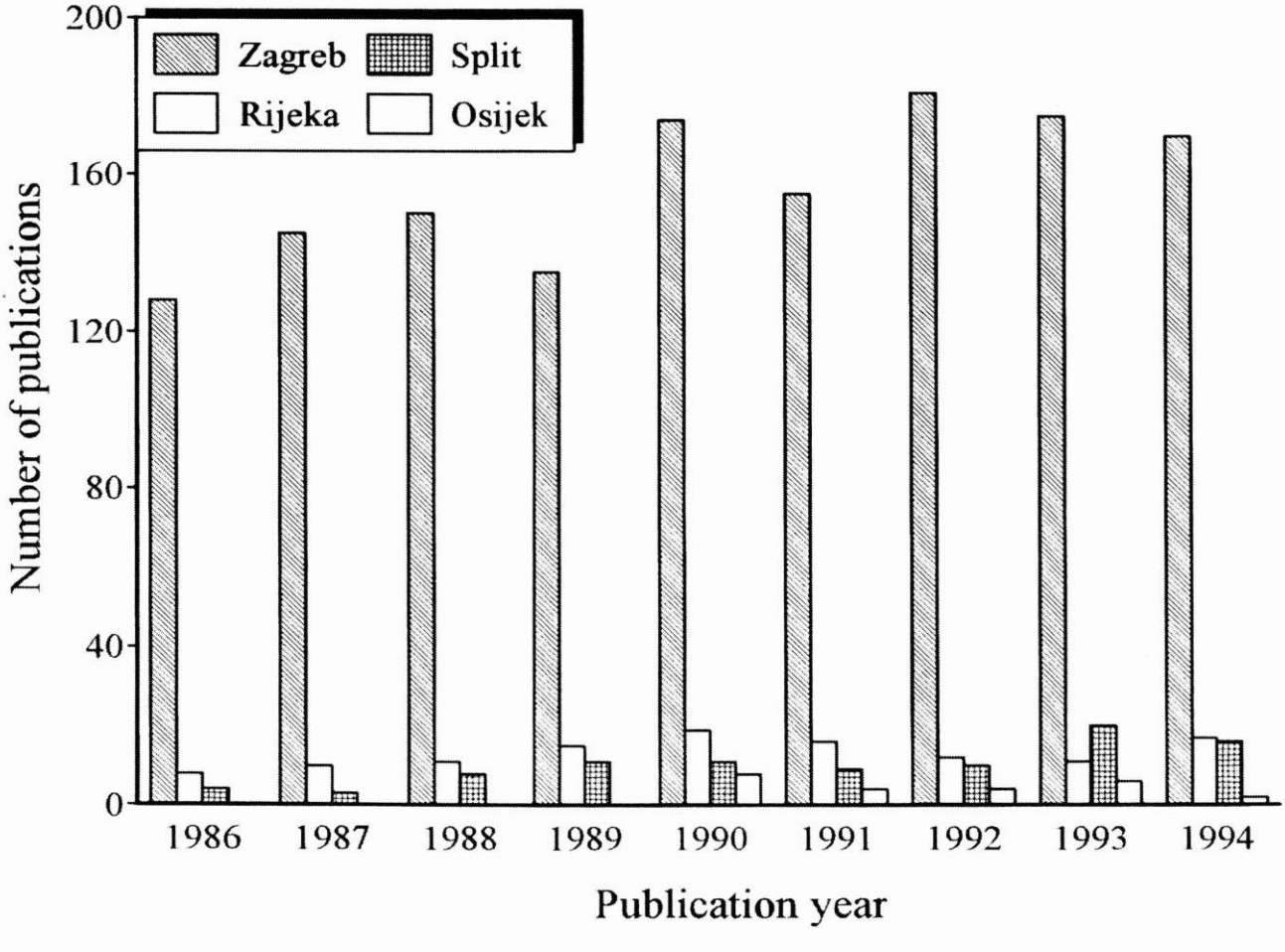

FIGURE 3. Publication activities at the Croatian medical schools shown as the number of articles indexed in the ISI SCIsearch database.

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of 6 years. We opted for the city name rather than the name of the university as the search word for data retrieval, in order to avoid the great inconsistency in using the institution addresses. Thus, the data shown in Figure 4 also comprise the publications by medical institutions and research institutes that are not affiliated to a particular university. By reason of simplicity, two Croatian university cities were compared with the Universities of Ulm and Garz, respectively. Although the results shown in Figure 4 do not allow a fully objective comparison, as they do not include only the research carried out at a particular university itself, the differences were still substantial, especially because the compared universities were of a similar size, as well as because the MEDLINE database is less restricted than the SCI search one, so some Croatian journals (Liječnički vjesnik and Acta Medica Croatica) are also indexed in it.

DISCUSSION

A recent analysis of the Science Citation Index data (4) has yielded results similar to those obtained by our analysis of the SCIsearch database - which is broader than the SCI - thus corroborating the conclusion that the overall productivity of Croatian scientists is too low. The situation is a little more optimistic if the publishing activity is considered as a function of the investments in science (4). In that case, however, a comparative analysis should be more detailed because of the strong correlation between the quality of a publication (high-impact journal) and the costs of the research - a fact familiar to everyone involved in serious science (1,5). Croatia's impact on the world's mainstream science (the papers listed in the SCI) is rather low, lagging behind that of countries like Nigeria, Kenya, Saudi Arabia, Singapore, Hong Kong, Slovakia, Czech Republic, Hungary, etc. (5). It is a not only the small number of papers

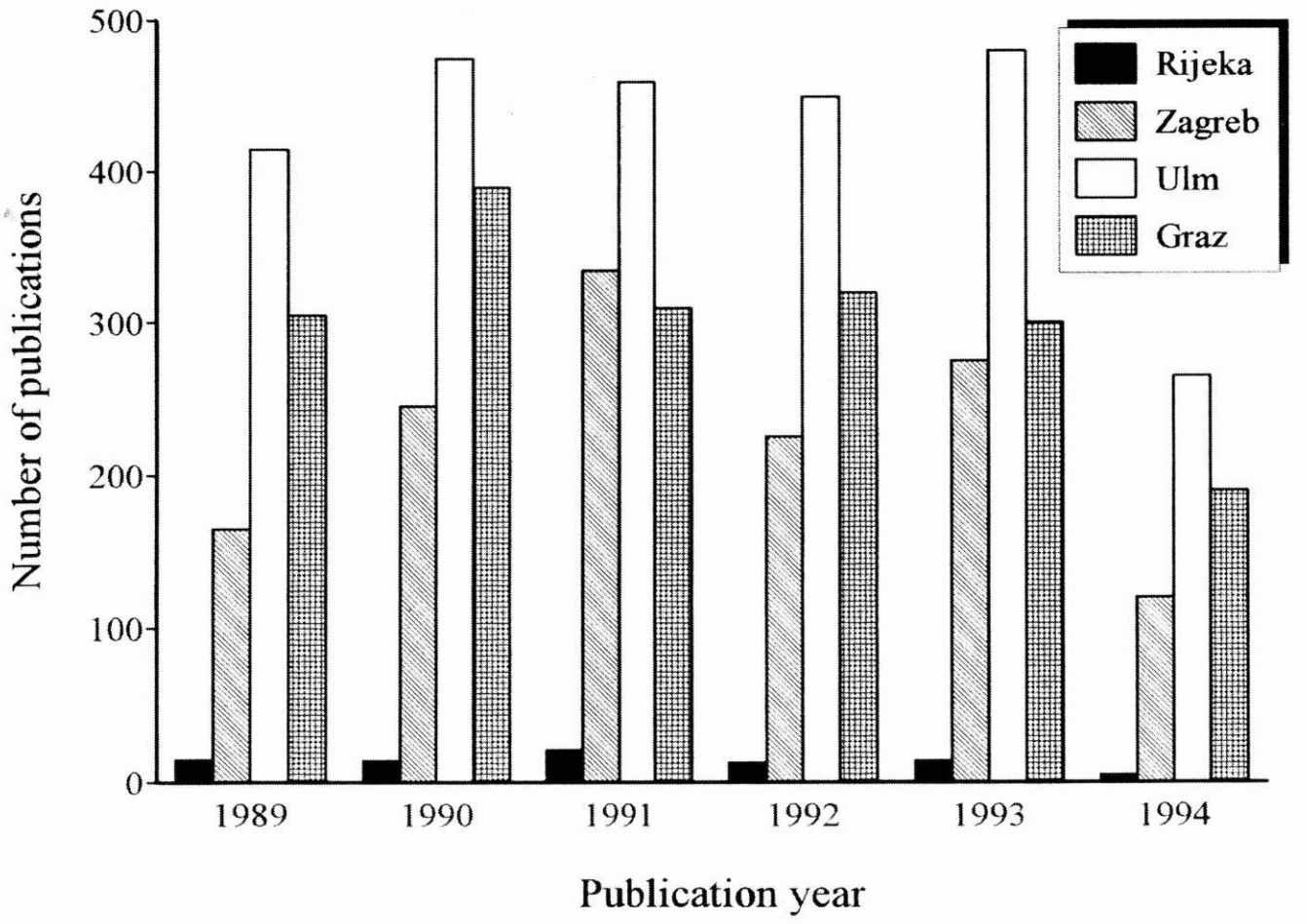

FIGURE 4. Biomedical publications of Croatian universities indexed in MEDLINE. The name of a city was the keyword in searching the database.

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published in high-quality journals that is alarming, but also the fact that very few recognizable groups of researchers have been formed so far. At some university centers, scientific work is hardly recognizable and, no matter which additional parameters one uses for the comparison (citations, number and validity of projects, advanced training of personnel), the regional universities fall significantly behind the University of Zagreb (S.Jonjić, unpublished data).

The opponents of the structural changes introduced by the newly enacted Bill of Science argue that the present social and economic situation in Croatia do not allow the introduction of more demanding criteria. This attitude is extremely dangerous because it permits that the existing negative selection will continue. The establishment of democracy cannot by itself improve the quality of scientific work or bring to an end the domination of mediocre scientists.

To carry out the demands of the new Bill of Science and National Scientific Program of the Republic of Croatia (1995), we have to improve our scientific basis, as well as competence in technology transfer essential to enter any international market. Further, the brain-drain should be prevented primarily by improving research conditions and personal standards for scientists. The Ministry of Science and Technology, responsible for defining the national science policy, should insist on funding competitive projects only. Croatian scientists must be encouraged to collaborate in order to create bodies of researchers in all scientific disciplines of interest to Croatia.

The evaluation of scientific work should be based on reviews made according to international scientific criteria, (i.e., the publishing of papers in journals that guarantee access to the world's generally assumed, the evaluation of scientific work is of special concern to small countries and small universities, where each researcher represents an individual. The same is true for the evaluation of scientific projects and the selection of scientists. For instance, none should be promoted to head of a department, institute, or hospital department - and accordingly allocated room and staff - before he/she has been evaluated on the basis of his/her publications and projects. Aspirations to leading publications are a major motivation behind scientific work and the guarantee of the continuation of scientific work in Croatia, no matter how small its output is in global terms. The introduction of modern technology into Croatian universities would additionally prompt research. Our science must become recognizable and able to follow contemporary trends in various scientific fields. Organized into small but competitive groups, researchers will be able to accumulate the knowledge necessary for high-quality training at undergraduate and graduate levels. If the present situation continues, our knowledge will increasingly lag behind the world achievements, and our students will not be recognized abroad.

The training of young scientists is a task of prime importance for us. Many Croatian scientists and best experts have gone abroad and remained there (6). In our opinion, a high-quality university can be achieved in three ways: first, by stimulating the return of top-quality Croatian scientists from all over the world; second, by providing a planned training of our scientists abroad and by guaranteeing them a satisfying scientific and personal standard upon their return to the country; and third, by stimulating an active participation of foreign scientists in Croatian research. It is encouraging that our new national Scientific Program recognizes the need for supporting the existing research connections with developed universities and stimulating the projects made in collaboration with international institutions.

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Sažetak

ZNANOST NA HRVATSKIM SVEUČILIŠTIMA

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Odjel za psihologiju i imunologiju Medicinskog fakulteta Rijeka

Cilj rada. Usporedba znanstvenih članaka tiskanih tijekom zadnjih deset godina u kojima su autori znanstvenici na sveučilištima u Zagrebu, Rijeci, Osijeku, Splitu s onima na Sveučilištu u Ulmu (Njemačka) i Gracu (Austrija).

Metode. Analiziran je broj radova dobiven pretraživanjem SCIsearch (Institute for Scientific Information (ISI) baze podataka i MEDLINE.

Rezultati. Uspoređujući ukupni broj radova koje registrira SCIsearch, znanstvenici na regionalnim hrvatskim sveučilištima objavili u tijeku desetogodišnjeg razdoblja znatno manje radova od ostalih sveučilišta uključenih u istraživanje. Podatak da su znanstvenici na našim sveučilištima objavili samo 0,42 (Osijek), 0,55 (Rijeka) i 0,75 (Split) radova po znastveniku tijekom desetogodišnjeg razdoblja sam za sebe dosta govori. Znastvenici Sveučilita u Zagrebu objavili su u istom razdoblju 1,65 radova po znanstveniku, uto je ipak vrlo malo ako se usporedi s produktivnošću znanstvenika na Sveučilištu u Ulmu (6,6 radova po znanstveniku). Slični se rezultati dobiju ako se napravi usporedba broja radova objavljenih na 1000 studenata kao mjere veličine sveučilišta.

Zaključak. Neovisno koji se pokazatelj koristio za usporedbu znanstvene razvijenosti, sva tri hrvatska regionalna sveučilišta bitno zaostaju za Sveučilištem u Zagrebu. Držimo da je razvijenost znanstvenog rada dosegla tako nisku razinu da to samo po sebi dovodi u pitanje njihov opstanak i daljnji razvoj. Glavne kočnice daljnjeg razvoja hrvatske znanosti su: (a) manjak vrhunskih znanstvenika koji bi pokrenuli razvoj, (b) sporost u provođenju reforme hrvatskih sveučilišta uz brojna opiranja pri samom začetku. Pri provođenju znanstvene politike, posebice pri probiru znanstvenih kadrova, treba čim prije uvesti univerzalne znanstvene kriterije. Novi Zakon o znanosti kao i Nacionalni znanstveni program pretstavljaju dobru osnovu za novi početak.

Ključne riječi: Hrvatska, izdavaštvo, sveučilišta, znanost