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# ACTA ADRIATICA: AN ANALYSIS OF CITATION PATTERNS

## ANALIZA CITIRANOSTI ČASOPISA ACTA ADRIATICA

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Reported is the information flow from the Croatian journal Acta Adriatica to international media. The analysis was performed by means of a convenient information transfer map. Based on empirical evidence, two major features of Acta Adriatica's citation patterns were established: (i) high extent of citedness and (ii) stability of the cluster of journals in marine biology field.

## INTRODUCTION

In our previous papers (Penava and Pravdić, 1989a, b), comprising comparative evaluation of information flow from national and international journals, **Acta Adriatica** was identified as the major carrier of scientific information produced in Croatia in the field of marine biology.

The method applied was based on citations, which in recent years, have frequently been used to look at various aspects of scientific literature. As early as in 1965, Price was the first to recommend a study of the topography of science through the analysis of journal-to-journal citation patterns. Narin *et al.* (1972) and Carpenter and Narin (1973) introduced the clustering process for partitioning of journals in a scientific discipline into clusters of related journals. The appearance of the **Science Citation Index (SCI)** in 1961 and of the **Journal Citation Reports (JCR)** in 1975, two

well known publications of the esteemed Institute for Scientific Information, Philadelphia, USA (ISI), considerably stimulated investigations of the citation relationships among scientific journals. A number of sophisticated methods and techniques have emerged to date. They were elaborated with the aim to detect the linkages between scientific fields as well as to better understand the related journal structure within particular fields. To mention only some of them: data could be found for journals in chemistry (C a r p e n t e r and N a r i n, 1973; P i n s k i, 1977), physics and molecular biology (C a r p e n t e r and N a r i n, 1973), instrumentation and control engineering (M i y a m o t o and N a k a y a m a, 1980), mathematics (S l a t e r, 1983), genetics (B a l o g, 1986), aquatic ecology and occupational hygiene (L e y d e s d o r f f, 1986), chemical physics (L e y d e s d o r f f, 1987), astrophysics and astronomy (T i j s e e n *et al.*, 1987), and agricultural biochemistry (B r a a m *et al.*, 1988).

The field of our interest was biology. However, in our investigations we added a specific nation-oriented condition. Namely, the relationships among scientific journals were considered, but only for those journals in biology in which the authors from Croatia published their papers. In this way, relying basically on the procedure by C a r p e n t e r and N a r i n (1973), it was possible:

(a) to reveal the areas of active research in Croatia,
(b) to detect the national journal which occupies the leading position for a given subfield, and
(c) to establish the information transfer process from Croatia to international media.

It was assumed that the chosen, defined group of authors publishing in biology might represent the scientific performance at the national level. Then, from the empirical models (P e n a v a and P r a v d i ć, 1989a), it appeared that among the biology subfields with major research activity there were: plant biology, animal physiology, endocrinology, cancer, biochemistry, and marine biology. Only in two subfields, the leading journals were found to be domestic ones; for plant biology it was **Acta Botanica Croatica,** for marine biology, **Acta Adriatica**. Based on aggregated citations, the links of the leading journals with related journals in the clusters formed, were organized and displayed in a novel-type information transfer map (P e n a v a and P r a v d i ć, 1989b).

In order to check whether the linkages of **Acta Adriatica** with foreign (i.e. other national and international) journals are random or whether they show the characteristics of a stable cluster, we expanded our study. To obtain another sample, full contents of **Acta Adriatica** were taken for scanning. In this paper we report on an analysis of the **Acta Adriatica** citation patterns with a special emphasis on the extent of the journal's citedness.

## METHODS AND DATA PROCESSING

### *Samples*

A sample means here, a set of those articles which were cited by other authors in a given period of time. Self - citations were excluded. Two approaches were applied for sample construction:

A - starting from a defined group of authors, i.e. from 130 scientists holding a PhD in biology. Inspection of SCI for the years 1965-1981 revealed (P e n a v a, 1984), among others, citations to their papers published in **Acta Adriatica** in the period from 1949 to 1978. There were 23 such papers. The sample A of the present study is based on these 23 papers.

B - starting from the journal; articles published in **Acta Adriatica** from 1973 to 1980 were now examined. In this eight-year period 115 papers were published; as 3 of these papers were already incorporated into the sample A, they were now omitted. Citations were found to 36 papers; these papers make the contents of the sample B.

### *Citation Search*

For sample B the searching was done by means of the SCISEARCH database through DIALOG Information Service, Palo Alto, CA, USA. The files covering the period 1974 - March 1989 were checked up for citations.

### *Citing Journals*

Citations to papers from each of the samples were found in a number of citing journals; in the sample A citations were distributed among 21, in the sample B among 37 journals. The lists according to the frequency of citations were prepared for both sets of the citing journals.

### *Extent of Citedness*

In order to obtain a scale which might indicate the extent of visibility achieved by a citation, impact factor data were applied. An explanation in support of such a choice was given earlier (P e n a v a and P r a v d i ć, 1989b). Impact factor data were taken from the JCR (1982).

*Subject Category Arrangement of Citing Journals*

The journals covered by SCI are divided according to the subject into aproximately 120 groups (SCI, 1987). This classification was used in order to distinguish the citing journals related to **Acta Adriatica.** It was found that they belong to following categories: Fisheries, Marine and Freshwater Biology, Oceanography, Water Resources, Zoology and several others.

*Information Transfer Map*

Based on interrelationships of scientific journals a novel design for the construction of information transfer maps was proposed (P e n a v a and P r a v d i ć, 1989b). **Acta Adriatica** found its place in the complex map which was constructed to combine citation data from national and international journals, around a backbone formed by joint citing journals. An excerpt from this information transfer map, encompassing only journals from the marine biology cluster, is presented in Fig. 1.

## RESULTS AND DISCUSSION

The features of the information transfer process in the marine biology cluster as displayed in Fig. 1 will be discussed first. Citations given to articles written by the Croatian biologists and published either in domestic or in foreign journals are observed as journal aggregates.

The map summarizes information flow towards seven joint citing journals: (a) from two domestic journals, **Acta Adriatica** and **Thalassia Jugoslavica**, on the left - hand side and (b) from eight foreign journals situated in the right-hand column. There are two types of lines denoting an ascending (a)- or a descending (d)-link between each pair of the cited and the citing journal. Since the sequence of the citing journals in the middle column reflects the relative values of their impact factors in descending order, the map provides a convenient tool for direct comparative evaluation of the extent of the journals' citedness. It appears that the first ranked citing journal is a review-type journal (**Advances in Marine Biology**) followed by two prestigeous foreign journals (**Marine Biology** and **Journal of the Marine Biological Association of the United Kingdom**).

Let us briefly contrast the citations to domestic journals on the one hand, and to foreign journals on the other. It is clearly demonstrated that **Acta Adriatica** is the most cited journal in the cluster; next to it is the foreign journal **Publicazioni della Stazione zoologica di Napoli.** As both journals are non-SCI journals, the under standing of the structure of their citedness is very important. The citation patterns of these two journals include the (a)-links to all highly ranked citing journals, whereas some foreign journals of high eminence (**Marine Biology**, **Netherlands Journal of Sea Research**) are cited by journals of lower impact, i.e. information flow is

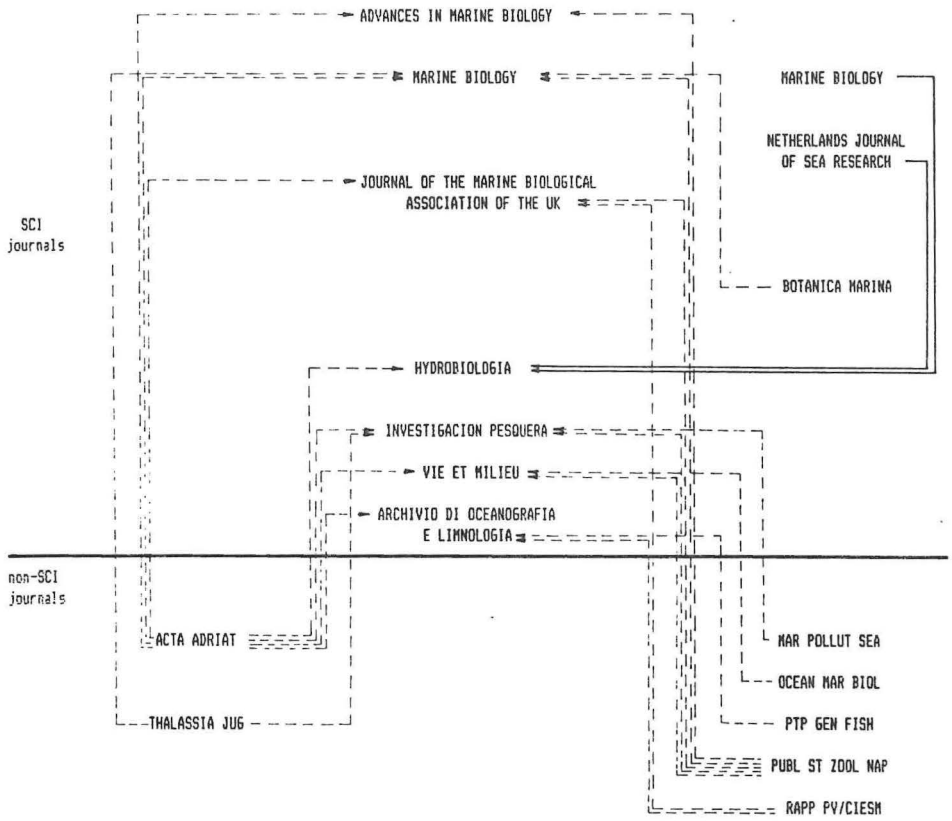


Fig. 1. Information transfer map for the marine biology subfield taken from the case study of biology in Croatia (excerpted from Fig. 2 in: P e n a v a and P r a v d i ć, 1989b). Combined are the inbformation flows from national (left) and foreign journals (right) towards the joint citing journals (in the middle). The arrows denote the direction from cited to citing journals. The links between the journals are of two types: ascending - broken lines and descending links - solid lines. The citing journals are arranged according to their impact factors, in descending order. Impact factors are are known for three of weight foreign cited journals; these journals are situated at the appropriate places on the same scale; non-SCI journals are in alphabetical order. Journal titles and abbreviations were taken from SCI.

expressed by the (d)-links.

The empirical example presented in Fig. 1 indicates that there is no correlation between the status of a scientific journal and the extent of citedness which its articles might achieve. We are making a point here, since scientists all over the world are almost convinced that publishing in prestigeous international journals would make their papers more easily visible. In a recent paper (L u u k k o n e n, 1989) under a provoking title 'Publish in a Visible Journal or Perish?', it is formulated as follows: "the extent to which authors from smaller countries are cited reveals not only the quality of the work they have produced, but also how well they have been able to overcome structural barriers, e.g. whether they have been able to enter networks which give them credibility as researchers in spite of the fact that they do not come from distinguished institutions, or whether they publish in visible international journals as contrasted with journals of national character, etc." In the case of the Croatian biologists publishing in the marine biology subfield, as revealed by our study, the visibility of the domestic journal **Acta Adriatica** is evident. It should also be emphasized that all foreign cited journals, in which papers by the contributing authors in this field appeared, are completely incorporated into a single map (Fig. 1). This fact leads to the assumption that the information transfer process from both domestic and foreign journals exhibits a high degree of similarity. Therefore, **Acta Adriatica**, the major source of information in the subfield, deserves additional analysis.

Whereas in Fig. 1 the cited/citing links are given only in part, i.e., as directed by the citing journals which are common to both domestic and foreign sources, full coverage of the **Acta Adriatica**'s citing journals is specified in Fig. 2. In this presentation there are 21 journals in which citations were found in the sample A, together with 37 citing journals for the sample B. All these journals are arranged in the same manner, in decreasing order of their impact factors. Titles of journals which appear in both samples are underlined; there are 9 recurring journals. Distribution of citations is noted as well.

It can be seen from Fig. 2 that the distribution patterns in both samples are similar: one or two citations are given by a large number of journals, while there are only a few journals with greater frequency of citations. This stands in full agreement with the well-known dispersal/concentration phenomenon (Y a b l o n s k y, 1980), which is typical of and common to all distributions of scientific productivity. In other words it means that there exists a great number of units with minimal contribution. This evident tendency towards a dispersal is always manifested, irrespective of the type of data: it occurs that the majority of authors in a set under investigation are single-paper authors; large number of journals give one citation each, etc. On the other hand, the concentration means that a small number of units carry a large amount of data (i.e. a great number of papers is produced by a small number of scientists; scientific literature in a given field is concentrated in a limited number of journals; only a few journals give greater number of citations to a specific item, etc.). As a result of this unsymmetrical frequency distribution, concentration of citations to **Acta Adriatica** in this case was

| Sample A | | | Sample B | A + B |
|---|---|---|---|---|
| [3] | 5.000 | * ADVANCES IN MARINE BIOLOGY | | 3 |
| | 2.650 | PROGRESS IN OCEANOGRAPHY | [1] | 1 |
| [1] | | * BIOLOGICAL BULLETIN | | 1 |
| | 2.000 | * OCEANOGRAPHY AND MARINE BIOLOGY | [1] | 1 |
| [13] | | * MARINE BIOLOGY | [6] | 19 |
| | | MARINE CHEMISTRY | [2] | 2 |
| | | * MARINE ENVIRONMENTAL RESEARCH | [1] | 1 |
| | | * MARINE POLLUTION BULLETIN | [1] | 1 |
| | | WATER RESEARCH | [2] | 2 |
| | | * JOURNAL OF EXPERIMENTAL MARINE BIOLOGY AND ECOLOGY | [1] | 2 |
| [1] | | | | |
| | | DEEP-SEA RESEARCH | [6] | 6 |
| | | JOURNAL OF PHYSICAL OCEANOGRAPHY | [1] | 1 |
| | | MARINE GEOLOGY | [1] | 1 |
| | | * JOURNAL OF PLANKTON RESEARCH | [1] | 1 |
| | | ESTUARINE, COASTAL AND SHELF SCIENCE | [2] | 2 |
| | | OCEANOLOGICA ACTA | [4] | 4 |
| | | * JOURNAL OF THE MARINE BIOLOGICAL ASSOCIATION OF THE UK | [1] | 14 |
| [13] | | | | |
| [2] | | * HELGOLANDER MEERESUNTERSUCHUNGEN | | 2 |
| | 0.996 | * JOURNAL OF FISH BIOLOGY | [1] | 1 |
| | | SCIENCE OF THE TOTAL ENVIRONMENT | [1] | 1 |
| | | JOURNAL WATER POLLUTION CONTROL FEDERATION | [3] | 4 |
| [1] | | | | |
| [2] | | * BOTANICA MARINA | [2] | 4 |
| [2] | | FISHERY BULLETIN | | 2 |
| | | CONTINENTAL SHELF RESEARCH | [1] | 1 |
| | | SCHWEIZERISCHE ZEITSCHRIFT FUER HYDROLOGIE | [1] | 1 |
| | | * JOURNAL OF CRUSTACEAN BIOLOGY | [2] | 2 |
| | | JOURNAL OF RADIOANALYTICAL CHEMISTRY | [1] | 1 |
| [1] | | * JOURNAL DU CONSEIL | | 1 |
| | | JOURNAL OF FORAMINIFERAL RESEARCH | [1] | 1 |
| | | * INTERNATIONALE REVUE DER GESAMTEN HYDROBIOLOGIE | [2] | 2 |
| [3] | | * HYDROBIOLOGIA | [8] | 11 |
| [6] | | * SARSIA | | 6 |
| | | NOVA HEDWIGIA | [1] | 1 |
| [1] | | MARINE FISHERIES REVIEW | | 1 |
| [1] | | ARCHIV FUER FISCHEREIWISSENSCHAFT | | 1 |
| [1] | | * CAHIERS DE BIOLOGIE MARINE | [3] | 4 |
| [2] | | BIJDRAGEN TOT DE DIERKUNDE/Contributions to Zoology/ | [2] | 4 |
| | | ANNEE BIOLOGIQUE | [1] | 1 |
| [1] | | ISRAEL JOURNAL OF ZOOLOGY | | 1 |
| | | REVUE D'EPIDEMIOLOGIE ET DE SANTE PUBLIQUE | [1] | 1 |
| | 0.200 | * TETHYS | [1] | 1 |
| [2] | | PROC OF THE ROYAL SOC OF EDINBURGH | | 2 |
| | | ANNALES DE L'INSTITUT OCEANOGRAPHIQUE | [3] | 3 |
| | | WATER SUPPLY AND MANAGEMENT | [1] | 1 |
| [6] | | * VIE ET MILIEU | | 6 |
| [9] | | * INVESTIGACION PESQUERA | [1] | 10 |
| [3] | | ARCHIVIO DI OCEANOGRAFIA E LIMNOLOGIA | | 3 |
| | | * MARINE ECOLOGY - PUBBLICAZIONI DELLA STAZIONE ZOOLOGICA DI NAPOLI | [7] | 7 |
| | | TRANSACTIONS OF THE AMERICAN MICROSCOPICAL SOCIETY | [1] | 1 |
| Total: 74 | | | 76 | 150 |

Fig. 2. Survey of all citations collected for **Acta Adriatica**. The citing journals are listed according to their impact factors in descending order. Journals in which citations were found in both samples are underlined. Journals belonging to the "Marine and Freshwater Biology" subject category are marked with an asterix.

found to be associated with four journals.

In order to get a better insight into the citation structure, the citing journals were grouped according to the subject categories. The corresponding breakdown of citations is given in Table 1. Inspection of data organized in such a way clearly shows certain differences between the two samples. In the sample A, journals belonging to 'Marine and Freshwater Biology', carry 61 out of 74 citations (82%). The rest is distributed among journals in categories such as 'Fisheries', 'Zoology', etc. Citations from the sample B are found in the following subgroups: 'Marine and Freshwater Biology' (39 citations, 51%), 'Oceanography' (28%), and 'Water Resources' (9%). In the analysis of these results major consideration is first given to the appearance of new subfields (OC and WR) in the sample B; besides, the absence of FI should not be overlooked. Plausible interpretation of these facts might be searched in:

(a) inequalities of the two study samples,
(b) possible changes in the authors' fields of interest over time,
(c) a number of reasons which are, however, beyond the scope of objective information scientists.

Our discussion will be, therefore, limited to (a). As explained in the preceding section, the genesis of the sample A differs from that of the sample B, suggesting that inequality of the two study samples would primarily refer to the authors' corpora structure. Whereas the authors of all papers in the sample A are biologists, the authors in the sample B are of unidentified, but most probably, various profiles. The consequences of this structural difference become apparent by means of the clustering procedure, through the groupings of the corresponding citing journals: the cluster of journals related to **Acta Adriatica**, as found for the sample A, belongs predominantly to the field of marine biology proving the major interest of the contributing biologists; the emergence of new clusters (of 'Oceanography' as well as of 'Water Resources' journals) in the sample B, on the other hand, indicates that among the **Acta Adriatica**'s authors, along with biologists there might be a number of scientists with different educational background (geologists, chemists, etc.), or possibly those having multi disciplinary interests. It should be noted in passing, that ten journals appearing in the OC cluster (e.g. **Deep-See Research**, **Oceanologica Acta**, **Estuarine, Coastal and Shelf Science**, **Marine Chemistry**, etc.) belong to the core oceanography journals, those which according to G a r f i e l d (1987), "make the biggest waves". This again exemplifies the high extent of the **Acta Adriatica**'s citedness.

Although comparative analysis of the data presented in Table 1 was started by stressing differences observed in citation patterns of the samples A and B, the most important feature of these data is, in fact, a rather high degree of congruence. Namely, in each of the samples the greatest number of citations (82% in A, 51% in B) is found in journals of the MFB subject category. Since in the sample B, full contents of **Acta**

**Table 1. Citations to Acta Adriatica** given by the citing journals, according to the subject category arrangement

| | | Number of citations | |
|---|---|---|---|
| **Subject category** | **Abbr.** | **Sample A** | **Sample B** |
| Fisheries | FI | 4 | - |
| Marine and Freshwater Biology | MFB | 61 | 39 |
| Oceanography | OC | - | 21 |
| Water Resources | WR | 1 | 7 |
| Zoology | ZO | 3 | 2 |
| Miscellaneous | | 5 | 7 |
| Total | | 74 | 76 |

Adriatica was taken at the outset, it appears that according to the citations received, the articles from marine biology subfield are the first-ranked.

This fact should, by no means, be taken as an indication of visibility relation of the MFB-articles and articles in other subfields, because the subject ratio of **Acta Adriatica**'s articles was not known. But, the fact that marine biology articles received the greatest number of citations enables us, at least, to use the MFB-fragment from the sample B for comparison with the sample A.

With this in mind, let us examine Fig. 2; journals from MFB subject category are marked by an asterisk. Not only that there are seven MFB-journals which carry citations in the sample A and again in the sample B, but moreover, in four of the recurring journals the citations are concentrated. These are the journals of high impact, **Marine Biology** (19 citations) and **Journal of the Marine Biological Association of the United Kingdom** (14) followed by **Hydrobiologia** (11), and **Investigacion pesquera** (10). It appears that citation patterns found for the sample B show distinct similarity with the data reported earlier (P e n a v a and P r a v d i ć, 1989b). Consequently, this finding might suggest an affirmative answer to the question about possible stability of the cluster formed by **Acta Adriatica** as the cited journal and a number of foreign citing journals in the marine biology subfield. By applying some other analytical techniques, a recent paper (L e y d e s d o r f f, 1986) demonstrated that essential stability over time occurred for journals in a related subject specialty such as aquatic ecology.

## CONCLUSIONS

The investigation of **Acta Adriatica**'s citation patterns performed here is based on bibliographic data. It is a typical example of the macro-scale study which involves the journal as the unit of analysis, assuming that characteristics of articles are transferred upwards to the journals in which they are published.

Methodology applied includes a fully objective approach to relevant experimental data with the aim to uncover certain regularities and patterns of behaviour of a given subject literature. However, cautious interpretation of the observed patterns permits fragmentary, but at least indicative conclusions. Since there are certainly no straightforward and simple relations in scientific publishing, the analysts trying to gather better understanding need to go beyond the scientometric measures.

Along these lines, **Acta Adriatica**, the leading journal for the field of marine biology in Croatia, was examined by citation analysis with respect to its role in the transfer of information towards the international media. Foreign journals which give citations to **Acta Adriatica** were identified; the linkages with a number of these citing journals were shown to be stable over time.

Next, the analysis of journals in the marine biology cluster, displayed in an appropriate information transfer map, revealed that non-SCI journals are linked with highly ranked and prestigeous international journals. Since the same was not established for the SCI-journals, it appears that there is no correlation between the status of a scientific journal and the extent of citedness which its articles might achieve. Empirical evidence for the extent of the **Acta Adriatica**'s citedness, proving its international visibility, might serve at least as an indirect indication of quality. More openly, this finding might be a reward for the **Acta Adriatica**'s present authors and an encouragement for the future ones.

Finally, the citation analysis, the method which is highly restrictive as a recognition tool in terms of the size of science in small countries (P r a v d i ć *et al.*, 1988), ap peared to be sensitive and reliable enough in the differentiation of national journals, especially in appreciation of the structure of citedness of non-SCI journals.

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# ANALIZA CITIRANOSTI ČASOPISA ACTA ADRIATICA

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## KRATKI SADRŽAJ

Ovaj je rad tipičan primjer iz reda studija na makro-razini, koje uzimaju časopis kao jedinicu, pretpostavljajući da se karakteristike članaka prenose na časopise u kojima su objavljeni. Oblici citiranosti časopisa **Acta Adriatica** analizirani su na osnovi bibliografskih podataka. Primijenjena metodologija temelji se na potpuno objektivnom pristupu relevantnim eksperimentalnim podacima s ciljem da se ustanove određene nepravilnosti i obrasci ponašanja stručne literature, pa je pažljivom interpretacijom primijećenih pojava moguće doći do indikativnih zaključaka. Razumljivo je da scientometrijska analiza ne može pružiti više nego fragmentarne zaključke.

Uz ova ograničenja, **Acta Adriatica** kao vodeći časopis za područje biologije mora u Hrvatskoj, ispitivana je citatnom analizom s obzirom na ulogu časopisa u prijenosu informacija u međunarodne medije. U radu su prikazani:

(1) pregled od ukupno 49 stranih časopisa koji citiraju **Acta Adriatica**;

(2) usporedba citiranosti dvaju uzoraka s rezultatom da je ustanovljena ponovljivost časopisa u kojima su citati nađeni, što ukazuje na određenu stabilnost veza između **Acta Adriatica** i srodnih časopisa u području biologije mora;

(3) prikladan shematski prikaz tokova informacija pomoću kojeg je vidljivo da se među časopisima koji citiraju **Acta Adriatica** nalaze časopisi velikog internacionalnog ugleda, tj. da domet citiranosti kojeg su postigli članci objavljeni u **Acta Adriatica** nije ovisan o činjenici da sam časopis nije uključen u sistem Instituta za znanstvene informacije (ISI, Philadelphia, SAD).

Citatna analiza, metoda koja je inače izrazito nepovoljna za procjenu znanstvenog doprinosa malih zemalja (Pravdić *et al.*, 1988), pokazuje se osjetljivom i dovoljno pouzdanom u razlikovanju domaćih časopisa, a posebno u razabiranju strukture njihove citiranosti.