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Classic papers published by Taiwanese scientists in the science citation index expanded: A bibliometric study

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The present study analysed quantitatively the classic papers published by Taiwanese scientists in the Science Citation Index Expanded. Documents that have been cited at least 1,000 times from Web of Science Core Collection since publication to the end of 2016 were assessed regarding their language, document type, journals, and Web of Science categories. The results showed that 59 Taiwan classic publications were found in SCI-EXPANDED between 1981 and 2014. Taiwanese scientists published more classic papers in medicine and physics related categories. Fourteen Taiwan independent classic publications were also analysed. National Taiwan University was the only had three Taiwan independent classic publications while Taipei Medical University and Overseas Chinese College of Commerce were the only private universities which published Taiwan independent classic publications. In addition, 'high impact sleeping beauties' and 'Green Giant' in Taiwan were also discussed.

Keywords: Bibliometric, High Impact Sleeping Beauties, Green Giants, Independent Publications, Taiwan

1. Introduction

Classic means excellent and exemplary [1] as well as have oriented, and stimulated the science [2]. Researchers have had the privilege of reading most of these classic papers when they first appeared find it a real pleasure to have them available under one cover [2]. The classic works are of particular importance because a high citation count is an indication of high impact or visibility to a broad range of research community [3]. In recent years, Ho's group

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studied classic publications with at least 1,000 total citations since publication to the recent year in the Web of Science Core Collection. It was reported that 45 countries had classic reviews with $TC_{2011} \geq 1,000$ [4] and 29 countries had single-author classic articles with $TC_{2012} \geq 1,000$ [5]. In addition, 75% of classic articles with $TC_{2010} \geq 1,000$ was found to be country independent publications from 29 countries and 25% internationally collaborative publications from 62 countries [6]. Classic articles in a country was recently studied, for example India ($TC_{2014} \geq 1,000$) [7], USA ($TC_{2014} \geq 1,000$) [8], Taiwan ($TC_{2012} \geq 1,000$) [9], and Canada ($TC_{2011} \geq 1,000$) [10]. Highly cited papers are important to the reputation of a university [11]. Citation counts are also correlated with the reputation of the scientists [12].

In this paper, some of the basic properties of the classic papers published by Taiwanese scientists in the Science Citation Index Expanded were discussed. In addition, 'high impact sleeping beauties' and 'Green Giant' in Taiwan were proposed.

2. Methodology

The publications reported were retrieved from the online version of Science Citation Index Expanded (SCI-EXPANDED), the Clarivate Analytics Web of Science database (updated on November 01, 2017). According to the Journal Citation Reports (JCR, 2016), SCI-EXPANDED indexes 8,879 journals with citation references from 177 Web of Science categories. We retrieved these published articles for analysis using the following search strategies:

Search strategy 1

We selected only those documents from 1900 to 2016 in SCI-EXPANDED.

Search strategy 2

Data were refined by countries/territories these documents in terms of 'Taiwan'. At least one author's affiliations are located in Taiwan (450,453 documents).

Search strategy 3

We recorded the total number of times a paper was cited in Web of Science Core Collection from its date of publication to the end of 2016 under the heading TC_{2016} [13]. Classic papers was defined as $TC_{2016} \geq 1,000$ [14]. The advantage of TC_{2016} as compared to the usual measure of total citations in the Web of Science Core Collection lies in its invariance, for it is not updated over time. Similarly, recent impact, C_{2016} , was the total number of citations of a paper in 2016 only [15]. We downloaded all records and number of citations for each paper for each year into spreadsheet software, and manipulated them using Microsoft Excel 2013 [16].

Table 1
Characteristics of document type

Document type	TP	%	TC ₂₀₁₆	CPP ₂₀₁₆	AU	AU/TP
Article	50	85	91,879	1,838	9,947	199
Review	8	14	12,572	1,572	2,105	263
Proceedings paper	2	3.4	3,053	1,527	33	17
Letter	1	1.7	1,167	1,167	4	4.0

TP: number of publications; TC₂₀₁₆: the total number of citations from Web of Science Core Collection since publication to the end of 2016; CPP₂₀₁₆: number of citations (TC₂₀₁₆) per publication (TP); AU: number of authors; AU/TP: number of authors (AU) per publication (TP)

3. Results and Discussion

3.1 Language of Publication and Document Type

A total of 59 Taiwan classic publications ($TC_{2016} \geq 1,000$) were published in SCI-EXPANDED between 1981 and 2014. All classic publications were published in English. The average value of TC_{2016} was 1,790 with the maximal value of 4,268. The 59 papers were found within four document types indexed in the Web of Science. Table 1 shows that the most common document type was the article (85% of the 59 publications) with average 199 authors in an article and TC_{2016} of 1,838. Articles entitled 'Observation of a new particle in the search for the Standard Model Higgs boson with the ATLAS detector at the LHC' [17] published in *Physics Letters B*, had the highest number of authors (2,932 authors). Nineteen articles (38% of the 50 articles) had more than 100 authors. Review entitled 'Guidelines for the use and interpretation of assays for monitoring autophagy' [18] published in *Autophagy*, also had 1,268 authors.

3.2 Journal and Web of Science Category

Taiwan classic papers were published in 32 journals in 33 Web of Science categories in SCI-EXPANDED. *New England Journal of Medicine* ($IF_{2016} = 72.406$) published the most Taiwan classic papers with seven papers (12% of the 59 publications), followed by *Physical Review Letters* ($IF_{2016} = 8.462$), with six papers, *Lancet* ($IF_{2016} = 47.831$) with five papers, *Nature* ($IF_{2016} = 40.137$) with four papers, and *Science* ($IF_{2016} = 37.205$) with three papers. As expected, the classic publications were published in journals with high impact factors [19]. Twelve journals (41% of 32 journals) had $IF_{2016} > 10$. Taiwan classic papers were also found in journals with lower IF_{2016} , such as *Scandinavian Journal of Statistics* ($IF_{2016} = 0.908$), *Nuclear Physics A* ($IF_{2016} = 1.916$), *Journal of Econometrics* ($IF_{2016} = 1.633$), and *Anticancer Research* ($IF_{2016} = 1.937$).

The top nine We of Science categories accounted at least three classic publications, including general and internal medicine (14 classic publications; 24% of the 59 classic pub-

lications), multidisciplinary sciences (9; 15%), multidisciplinary physics (6; 10%), oncology (5; 8.5%), astronomy and astrophysics (4; 6.8%), multidisciplinary chemistry (4; 6.8%), nuclear physics (4; 6.8%), particles and fields physics (3; 5.1%), and artificial intelligence computer science (3; 5.1%). Furthermore, 21 classic papers were published in five categories related to medicine such as general and internal medicine (14 papers), oncology (5 papers), neurosciences (2 papers), neuroimaging (1 paper), and radiology, nuclear medicine and medical imaging (1 paper) and 14 were published in six categories related to physics including multidisciplinary physics (6 papers), astronomy and astrophysics (4 papers), nuclear physics (4 papers), particles and fields physics (3 papers), applied physics (1 article), and condensed matter physics (1 article).

3.2 Collaborations

Among the 59 Taiwan classic publications, 45 publications (76% of 59 publications) were international collaborations with 84 countries and 14 (24%) were Taiwan independent publications with 17 institutions in Taiwan. Citations per publication for internationally collaborative publications ($CPP_{2016} = 1,878$) was higher than that of Taiwan independent publications ($CPP_{2016} = 1,507$). Average numbers of author in the internationally collaborative publications (267 authors) was found much higher than that of Taiwan independent publications (4.2 authors). In total, 19 Taiwan classic publications had more than 100 authors. Three of the 59 Taiwan classic publications had more than 1,000 authors such as article entitled ‘Observation of a new particle in the search for the Standard Model Higgs boson with the ATLAS detector at the LHC’ [17] published by 2,932 authors from 232 institutions in 40 countries; ‘Observation of a new boson at a mass of 125 GeV with the CMS experiment at the LHC’ [20] published by 2,891 authors from 210 institutions in 42 countries; and review entitled ‘Guidelines for the use and interpretation of assays for monitoring autophagy’ [18] published by 1,268 authors from 602 institutions in 51 countries. It was reported that the classic articles in SCI-EXPANDED were published by a high percentage of single-author [6]. Similarly, fewer authors could be also found in classic reviews in SCI-EXPANDED [4].

Table 2
The 14 Taiwan independent classic publications

Rank (TC ₂₀₁₆)	Rank (C ₂₀₁₆)	DT	Publication information [reference]
1 (2931)	4 (320)	article	Hsu, C.W. and Lin, C.J. (2002), A comparison of methods for multiclass support vector machines. <i>IEEE Transactions on Neural Networks</i> , 13 (2), 415-425. [25]
2 (2210)	3 (338)	review	Cheng, Y.J., Yang, S.H. and Hsu, C.S. (2009), Synthesis of conjugated polymers for organic solar cell applications. <i>Chemical Reviews</i> , 109 (11), 5868-5923. [26]

Contd...

3 (2102)	10 (59)	article	Beasley, R.P., Lin, C.C., Hwang, L.Y. and Chien, C.S. (1981), Hepatocellular carcinoma and hepatitis B virus: A prospective-study of 22707 men in Taiwan. <i>Lancet</i> , 318 (8256), 1129-1133. [27]
4 (2068)	1 (903)	article	Chang, C.C. and Lin, C.J. (2011), LIBSVM: A library for support vector machines. <i>ACM Transactions on Intelligent Systems and Technology</i> , 2 (3S), Article Number: 27. [28]
5 (1760)	2 (442)	article	Fan, R.E., Chang, K.W., Hsieh, C.J., Wang, X.R. and Lin, C.J. (2008), LIBLINEAR: A library for large linear classification. <i>Journal of Machine Learning Research</i> , 9 , 1871-1874. [29]
6 (1375)	6 (175)	article	Chao, A. (1984), Nonparametric estimation of the number of classes in a population. <i>Scandinavian Journal of Statistics</i> , 11 (4), 265-270. [30]
7 (1225)	5 (283)	review	Ho, Y.S. (2006), Review of second-order models for adsorption systems. <i>Journal of Hazardous Materials</i> , 136 (3), 681-689. [31]
8 (1167)	12 (42)	letter	Yu, Y.Y., Chang, S.S., Lee, C.L. and Wang, C.R.C. (1997), Gold nanorods: Electrochemical synthesis and optical properties. <i>Journal of Physical Chemistry B</i> , 101 (34), 6661-6664. [32]
9 (1099)	14 (35)	article	Chang, M.H., Chen, C.J., Lai, M.S., Hsu, H.M., Wu, T.C., Kong, M.S., Liang, D.C., Shau, W.Y. and Chen, D.S. (1997), Universal hepatitis B vaccination in Taiwan and the incidence of hepatocellular carcinoma in children. <i>New England Journal of Medicine</i> , 336 (26), 1855-1859. [33]
10 (1073)	8 (106)	article	Cheng, A.L., Hsu, C.H., Lin, J.K., Hsu, M.M., Ho, Y.F., Shen, T.S., Ko, J.Y., Lin, J.T., Lin, B.R., Wu, M.S., Yu, H.S., Jee, S.H., Chen, G.S., Chen, T.M., Chen, C.A., Lai, M.K., Pu, Y.S., Pan, M.H., Wang, Y.J., Tsai, C.C. and Hsieh, C.Y. (2001), Phase I clinical trial of curcumin, a chemopreventive agent, in patients with high-risk or pre-malignant lesions. <i>Anticancer Research</i> , 21 (4B), 2895-2900. [34]
11 (1045)	9 (71)	article	Yen, G.C. and Chen, H.Y. (1995), Antioxidant activity of various tea extracts in relation to their antimutagenicity. <i>Journal of Agricultural and Food Chemistry</i> , 43 (1), 27-32. [35]
12 (1025)	7 (127)	article	Chen, C.T. (2000), Extensions of the TOPSIS for group decision-making under fuzzy environment. <i>Fuzzy Sets and Systems</i> , 114 (1), 1-9. [36]
13 (1011)	11 (48)	article	Chu, J.H. and I, L. (1994), Direct observation of coulomb crystals and liquids in strongly coupled Rf dusty plasmas. <i>Physical Review Letters</i> , 72 (25), 4009-4012. [37]
14 (1002)	13 (40)	article	Wu, J.J. and Liu, S.C. (2002), Low-temperature growth of well-aligned ZnO nanorods by chemical vapor deposition. <i>Advanced Materials</i> , 14 (3), 215-217. [38]

TC_{2016} : the total number of citations from Web of Science Core Collection since its date of publication to the end of 2016; C_{2016} : the total number of citations in 2016; DT: document type.

3.3 Taiwan Independent Classic Publications

It is generally accepted that equal credit is not given to all authors in a publication. It has been also reported that the honorary authorship is still regarded as a minor digression and the honorary or gift authorship is unacceptable in the *Lancet* [21]. Bibliometric analysis of country independent publications were studied in recent years, for example China [22], Serbia [23], the US [8], Czech, and Slovak [24]. Total number of Taiwan independent classic publications was 14, including 11 articles, two reviews, and one letter from 1981 to 2011 (Table 2). These papers were published in 14 journals in 22 Web of Science categories in SCI-EXPANDED. Three of 14 papers were published in Web of Science category of artificial intelligence computer science and two were published in multidisciplinary chemistry, physical chemistry, theory and methods computer science, general and internal medicine, and statistics and probability respectively. Among the 14 Taiwan independent classic publications, three were inter-institutionally collaborative publications with CPP_{2016} of 1,425 and 11 were institutionally independent publications with CPP_{2016} of 1,529.

3.4 Authors of the Taiwan Independent Classic Publications

The 14 Taiwan independent classic publications were authored by 57 authors from 17 institutions, including 14 first authors from 11 institutions and 12 corresponding authors from 11 institutions. C.J. Lin from Department of Computer Science and Information Engineering in National Taiwan University was the only one classic author who published three Taiwan independent classic publications as all corresponding author but no any first author articles. Only three Taiwan independent classic publications were published by single author such as article entitled 'Nonparametric estimation of the number of classes in a population' [30] in *Scandinavian Journal of Statistics* by A. Chao from Institute of Statistics in National Tsing Hua University; review entitled 'Review of second-order models for adsorption systems' [31] in *Journal of Hazardous Materials* by Y.S. Ho from Department of Public Health in Taipei Medical University; and article entitled 'Extensions of the TOPSIS for group decision-making under fuzzy environment' [36] in *Fuzzy Sets and Systems* by C.T. Chen from Overseas Chinese College of Commerce. Y.S. Ho and C.T. Chen was the only two first and corresponding author who are from a private university. It is not surprised that national universities have much more support from government than that of private universities in Taiwan. In addition, one of Ho's articles 'Pseudo-second order model for sorption processes' [39] has been ranked top with annual citations in Web of Science category of chemical engineering since 2008 [15].

National Taiwan University which is the top university in Taiwan, had three classic first authors and one classic corresponding author (Table 3). However, these three first authors are not in research institutions or universities. It is clear that classic corresponding authors do not change their institutions from publication one to current one. Only two classic single authors in private institutions such as Taipei Medical University and Overseas Chinese College of Commerce were moved to Asia University (private university) and National United University (national university) respectively. Research support might

Table 3

First authors and corresponding authors of the 14 Taiwan independent classic publications

Authors	Job title	FP	RP	Affiliation in the paper	Current affiliation
C.J. Lin	Distinguished Professor	0	3	National Taiwan University	National Taiwan University
J.H. Chu	(Deceased)	1	1	National Central University	(Deceased)
M.H. Chang	Academic Fellow	1	1	National Taiwan University Hospital	National Taiwan University Hospital
A. Chao	Chair Professor	1	1	National Tsing Hua University	National Tsing Hua University
Y.S. Ho	Associate Professor	1	1	Taipei Medical University	Asia University
R.P. Beasley	(Deceased)	1	1	University of Washington Medical Research Unit and National Taiwan University	(Deceased)
A.L. Cheng	Adjunct Professor	1	1	National Taiwan University Hospital	National Taiwan University Hospital
Y.J. Cheng	Professor	1	1	National Chiao Tung University	National Chiao Tung University
J.J. Wu	Professor	1	1	National Chung Cheng University	National Chung Cheng University
C.T. Chen	Professor	1	1	Overseas Chinese College of Commerce	National United University
C.R.C. Wang	Professor	0	1	National Chung Cheng University	National Chung Cheng University
R.E. Fan	*	1	0	National Taiwan University	*
Y.Y. Yu	*	1	0	National Chung Cheng University	*
C.W. Hsu	*	1	0	National Taiwan University	*
C.C. Chang	*	1	0	National Taiwan University	*

FP: number of Taiwan independent classic publications as first author; RP: number of Taiwan independent classic publications as corresponding author; *: are not in research institutions or universities.

be one of the reasons for not keeping classic author in a private university. Result might be an evidence that university's ranking should be supported by classic authors. Goodall [40] reported that the core business of a university is research, teaching, and even social services, but research quality is what separates top universities from their competitors. A positive correlation between the lifetime citations of a faculty and the position of that university in the global ranking was found [41]. Furthermore, Ho [6] pointed that Harvard University published the most classic articles in SCI-EXPANDED.

3.5 The Lifespan of the 14 Taiwan Independent Classic Publications

Figures 1 and 2 show histories of citations of the 14 Taiwan independent classic publications ($TC_{2016} > 1,000$). Two of these 14 publications were published in the 1980s, four in the 1990s, seven in the 2000s, and only one was published in 2011. Publications such as Cheng et al. [26] and Hsu and Lin [25] in Fig. 1 as well as Yu et al. [32], Chang et al. [28], Yen and Chen [35] in Fig. 2 had decreasing citation trend in recent year. Article entitled 'Hepatocellular carcinoma and hepatitis B virus: A prospective-study of 22707 men in Taiwan' [27] reached a citation plateau after two years publication and keep in 34 year with average annual citations of 60.

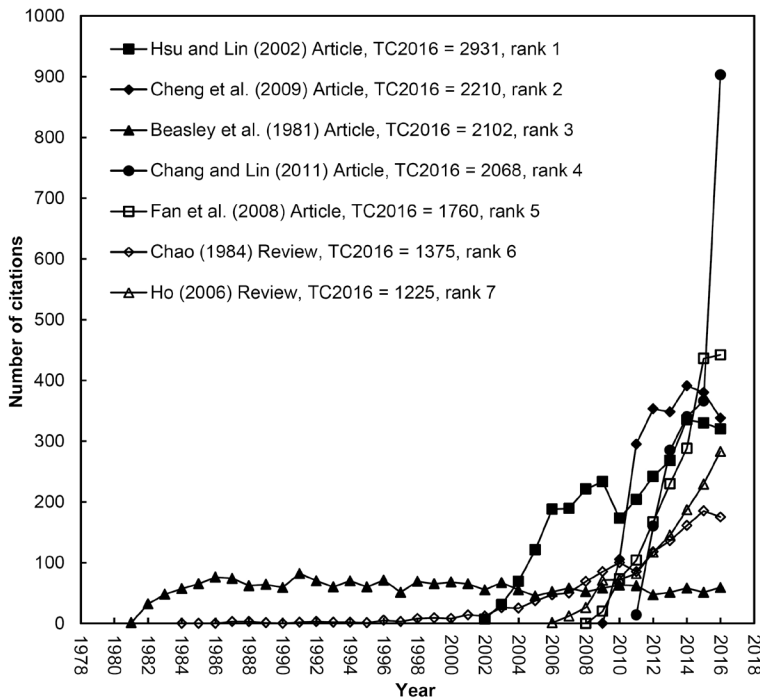


Figure 1
Taiwan independent classic publications ($TC_{2016} > 1,200$).

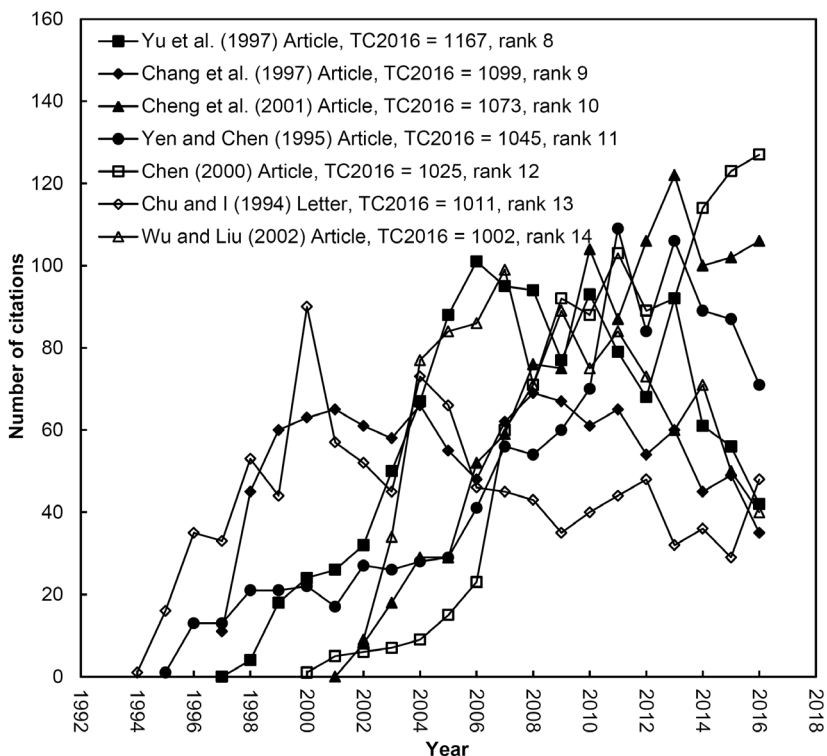


Figure 2

Taiwan independent classic publications ($1,000 < TC_{2016} > 1,200$).

3.6 High Impact Sleeping Beauty and Green Giant

Normally, it can be found that highly cited articles published later are at a disadvantage in terms of citations compared to those published earlier in research fields, for example psychology [42], Antarctic [43], and thermodynamics [44] as well as highly cited publications in a country [7-10]. In fact, highly cited articles can be also found in recent years [15]. Some articles, known as ‘sleeping beauties’, had low citations after publication, but gain citations much later [45]. van Raan defined the three characteristics of such publications to be depth of sleep, length of sleep, and awakening intensity [46]. Ho and Hartley [47] proposed ‘high impact sleeping beauties’, sleeping beauties with high citations in recent year.

Among the 14 Taiwan independent classic publications, article entitled ‘Nonparametric estimation of the number of classes in a population’ [30] by A. Chao from National Tsing Hua University was the only ‘high impact sleeping beauties’ with both TC_{2016} (1,375) and C_{2016} (175) were ranked 6th in Taiwan respectively. The length of the deep sleep was seven years, the length of the less deep sleep was 14 years; and the years to reach 100 annual citations after the less deep sleep was 15 years (Fig. 1). Chao [30] proposed a nonparametric

method to estimate the number of classes when most of the information is concentrated on the low order occupancy numbers in this 'high impact sleeping beauties'.

Green Giants

Green Giants are articles have sharply increasing citations after publication for some years compared with others in the same field, and they quickly become high impact publications in recent year with high C_{year} measures. For example article entitled 'Pharmaceuticals, hormones, and other organic wastewater contaminants in U.S. streams, 1999-2000: A national reconnaissance' [48] in category of environmental sciences [49] and 'The MOS 36-Item short-form health survey (SF-36). I. Conceptual-framework and item selection' [50] in pain research [51]. However, numerous articles with high citations for only one of two years after publication, and then their citation rates decline [4,8]. Such articles may be said to have a 'short fuse' to keep sharply citation trend.

Article entitled 'LIBSVM: A library for support vector machines' [28] by C.C. Chang and C.J. Lin from National Taiwan University was the only 'Green Giant' which ranked 1st with C_{2016} which is much higher than any others (Fig. 1). Figure 1 shows the 'Green Giant' in Taiwan had sharply increasing citation rates for five years after its publication.

4. Conclusion

A total of 59 Taiwan classic publications were found in SCI-EXPANDED between 1981 and 2014. English was the only used language. Most document type was article with the highest citations per publication. High average number of authors in a publication was found. Most of the classic papers published in journals with high impact factors such as *New England Journal of Medicine*, *Lancet*, and *Nature*. Taiwanese scientists published the most classic papers in Web of Science category related to medicine. Only 14 classic papers were Taiwan independent publications. National universities contributed more to the Taiwan independent classic publications than private universities. C.J. Lin from National Taiwan University ranked top while Y.S. Ho was the only one author from private university recently. Finally, article by A. Chao from National Tsing Hua University was the only 'high impact sleeping beauties' and article by C.C. Chang and C.J. Lin from National Taiwan University was the only 'Green Giant' in Taiwan.

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