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The pre-Linnaean *herbarium* of Paolo Boccone (1633–1704) kept in Leiden (the Netherlands) and its connections with the imprinted one in Paris

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ABSTRACT

The subject of this paper is the study of the pre-Linnaean *herbarium* of Paolo Boccone (1633–1704) which is kept in Leiden (the Netherlands) and its connections with two works of the same author: the imprinted *herbarium* kept in Paris in the Bibliothèques Interuniversitaires de Médecine and the printed volume "*Icones et Descriptiones*" of 1674. By means of the comparative analysis of the three works we have verified the existence of numerous similarities (even a complete overlap) between the samples of the Leiden *herbarium* (some with visible traces of ink), the imprints of the Paris *herbarium* and the figures of "*Icones et Descriptiones*". The drawings to be found in this work, thanks to the realistic fidelity that distinguishes them, have been used by various authors until quite recent times for the description of new *taxa*. This shows the importance and the usefulness of the *herbarium* in question for the processes of typification. The taxonomic identification of the specimens (121 angiosperms and 1 alga) allowed us to designate the lectotype and the epitype of *Daucus gingidium* subsp. *polygamus* (Gouan) Onno and of *Daucus carota* subsp. *commutatus* (Paol.) Thell.

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Introduction

Paolo Boccone, a Sicilian pre-Linnaean botanist and author of relevant floristic works, such as *Icones et Descriptiones* (1674), *Museo di fisica* (1697a), *Museo di piante rare* of 1697b, had important contacts with the botanists of his time. His numerous journeys to France, the Low Countries, England (c.1670–1674), then to Rome, Liguria, Corsica (c.1677–1684) and, later, Austria, Prussia, Poland and Venice (c.1694–1698) were occasions for exchanging information, experiences and, above all, botanical material (Pulvirenti et al. 2017a). His presence and his scientific relationships are attested by the *herbaria* present in various European cities (Paris, Lyons, Vienna, Innsbruck, Oxford, Leiden and Wroclaw). They have been object of study since the eighteenth century. Only one volume of *exsiccata* attributed to Boccone and currently kept in the Civica and A. Ursino Recupero joint Libraries of Catania still exists in Italy. It has been recently studied (Pulvirenti et al. 2017b).

The pre-Linnaean *herbarium* made by Boccone (Figure 1) and kept in Naturalis Biodiversity Center (L) is part of the collection of Hieronymus van Beverningh (1614–1690), an important Dutch politician and founder of the Leiden Botanical Garden (Thijsse 2007). This *herbarium* is particularly interesting, both for the samples present and as a testimony of the intensity of exchanging botanical materials that characterized the European scientific community of the seventeenth century (Pulvirenti, Costa, et al. 2015). In the first place, we must point out the usefulness of the Dutch *herbarium* as a demonstration of the process of preparation of a printed botanical work in the seventeenth century and of the experiments of techniques of representation. It is certain that it served as a basis for the plates of "*Icones et Descriptiones*" of 1674. The demonstration of this is the fact that most of the *taxa* present in the *herbarium* are described and drawn in it. On the back of many sheets of the studied *herbarium* proofs of engravings corresponding to numerous plates of the published volume were glued (Figure 2).

Boccone's "*Icones et Descriptiones*" has had a large circulation among botanists and various authors have mentioned the drawings contained therein for the description of new *taxa*. For this reason, some samples of the Dutch *herbarium* are *typi*. In this article two, belonging to genus *Daucus*, are designated.

On the other hand, the experimentation of techniques of representation is demonstrated by the presence in the *herbarium* of samples that show visible traces of ink. Some of them were certainly used for the realization of the imprinted *herbarium* kept in Paris, in the Bibliothèques Interuniversitaires de Médecine (BIUM). In this library, under the heading "Erbario manoscritto di Paolo Boccone", we find (shelfmark 2039/27) a small notebook (signed by Boccone, called "Cahier de Chantilly"), which lists the 125 plants with which he produced the *herbarium* kept in the Muséum National d'Histoire Naturelle and an imprinted *herbarium* made up of 128 sheets, with about 230 plant imprints (Pulvirenti et al. 2017b). Some imprints of this "*hortus impressus*"

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Figure 1. Spine and cardboard cover (Naturalis Biodiversity Center, Leiden, the Netherlands).



Figure 2. (a) Sheet number 84 (recto); (b) sheet number 83 (verso) (Naturalis Biodiversity Center, Leiden, the Netherlands); (c) Table 31 (page 60) of "*Icones et Descriptiones*".

(available online: http://www.biusante.parisdescartes.fr/boccone/) are superimposable, totally or partially, on the samples of the Dutch *herbarium* (Figure 3). For this reason, we think that the sequence of the preparation of "*Icones et Descriptiones*" consists of the making of the imprinted *herbarium* kept in Paris, of the realization of the *herbarium* kept in Leiden and, finally, of the publication of the volume in London. It is in perfect harmony with the chronology of the author's journeys, which emerges from his works (Pulvirenti et al. 2017a) and from signed documents.



Figure 3. (a) Sheet number 17 (recto) of L herbarium (Naturalis Biodiversity Center, Leiden, the Netherlands); (b) sheet number 3 of BIUM herbarium (http://www.biusante.parisdescartes.fr/boccone/).

Realism and techniques of botanical representation in the seventeenth century

In the seventeenth century, the widespread need for realistic representation (e.g. Caravaggio, Rembrandt) involved the whole of the scientific and naturalistic community, as is also attested by the research of Adriaan van den Spieghel (1606), and induced botanists to abandon the traditional iconography of *herbaria picta* and to try other paths (Hentschel 2014). Boccone had the opportunity to anticipate his scientific and methodological project to Angelo Matteo Bonfante de Cassarinis, a Sicilian botanist with whom he corresponded, in a letter kept in the Municipal Library of Palermo among the author's manuscripts (Boccone 1670). He had sensed the problem from the first years of his iconographic and aesthetic research. The proofs are easily deducible from his correspondence with Bonfante and his intense association with the naturalistic painter Agostino Scilla (1629–1700). Thanks to his curiosity for naturalistic enquiring and his compulsive need to experiment new techniques of plant representation, Boccone lived to the full the transition from the *herbaria picta* to the *horti sicci*, taking an active part in the debate on the usefulness of iconography, on representative realism and on direct observation (Pulvirenti et al. 2017a). In order, better to represent the structure of a plant, Boccone experimented with the techniques of imprinted *herbaria* (Arber 1912; De Conihout 1993), as is proved by the *horti impressi* of Chantilly, Oxford and Vienna. He was convinced, however, of the inadequacy of this method and of the need to facilitate the study of plants by comparing the drawings with *exsiccata*, as one can read on the title page of one of the *herbaria* kept in Vienna (Lack 2003).

On the other hand, Boccone himself was unable to avoid the increasing number of requests for information that were spread, stimulated and consented by the progress of the printing techniques. His work was, therefore, a continuous effort to adapt printed images to the realistic representations made up of the imprints of samples of *exsiccata* dipped in ink. In "*Icones et Descriptiones*", the experimentation with the techniques of representation probably achieved the most significant results. The links between *horti impressi*, *horti sicci* and printed works that can be inferred from a comparison between Parisian finds, Dutch finds and the published volume, are a visible proof. An innovative scientific method and a research project appreciated all over Europe were being experimented. However, in the following century, graphic representation was destined little by little to lose importance and be replaced by standardized verbal representation according to the Linnaean canons (Wragge-Morley 2010), as is demonstrated by the failure of "*Panphyton siculum*" by Francesco Cupani (1657–1710), which was never published (Costa, Pavone, Carbonaro, et al. 2016).

Methodology

Through high-quality digitized images, provided by Naturalis Biodiversity Center, the specimens of Boccone *herbarium*, have preliminary been identified. The determination has been deepened with the subsequent taxonomic analysis carried out on the original samples directly.

A list of all specimens associated with Boccone's historical *herbarium* was prepared (Supplementary Table 1), including for each sample the following information:

(1) number of the *herbarium* sheet under which the sample is currently placed;
(2) engravings presence and their correspondence with "*Icones et Descriptiones*" plates;
(3) literal transcription of original name proposed in the *herbarium*; the absence of the name is indicated by "/";

(4) current taxonomic identification. We have followed treatments such as Conti et al. (2005), Celesti-Grapow et al. (2009), Euro+Med (2006–2017), and partially Giardina et al. (2007) and Pignatti (1982).

Moreover, a list of alphabetically arranged *taxa* is presented (Appendix 1); this list includes the plants of the *herbarium* that we studied and that we were able to identify; in brackets the corresponding page and plate's number of "*Icones et Descriptiones*", on which the sample is drawn, is indicated.

To be able to compare the images of the BIUM *herbarium* with those of L *herbarium*, the software Image Comparer™ 3.8 Build 713 has been utilized. The procedure was performed through two different stages: pre-processing and comparison units. During the first step, the images were prepared to have the same resolution, colour number and compression level, using Adobe Photoshop 7.0. Then, with the *lasso snapping* tool, the selections around the sample have been drawing and the contour from selected specimens was extracted. In the second step, analysis process has been performed and the images were processed by Image Comparer. The software finds similar as well as fully identical images. In comparison process, a similarity threshold of 70% for similar images was configured. Thus, the algorithm processed only those images that had a similarity ratio higher than this value. Two galleries were created so two image groups were processed. Each image from the first gallery (BIUM images) was compared with each image in the second gallery (L images). The comparison results were classified into three similarity classes: 70–80, 81–90 and 91–100%. To highlight our results, we prepared a comparison table (Table 1) in which are indicated:

(1) alphabetically arranged *taxa*;
(2) corresponding samples, numbered progressively;
(3) number of the BIUM *herbarium* sheet;
(4) number of the L *herbarium* sheet;
(5) correspondence between the imprint's image (BIUM) and the sample's image (L), expressed as a percentage;
(6) additional remarks.

Results

The volume of *exsiccata* that is the object of this study is very large (17.13 × 12.40 inches). It is made up of various files put together in one block and bound with a cover of pressed brown cardboard, with the corners and the spine in white parchment, and closed by greenish strings which have been reduced to stumps. On the spine we find the inscription "*Boccone. Herbarium Siculum.*" in Gothic letters (Figure 1). The whole volume is made up of 174 very thick paper pages. On some sheets we find a watermark depicting a five-pointed star. It is structured in the following way:

- 1 blank sheet;
- 1 sheet with title page (Figure 4);
- 1 blank sheet, on the other side of which there is the first engraving (a sheet that has been cut and glued);
- 168 sheets with *exsiccata*, numbered in the top right-hand corner; on the back of 32 sheets there are the other engravings (Supplementary Table 1);
- 3 blank sheets.

On 11 sheets (no. 1, 13, 36, 40, 41, 85, 94, 100, 123, 149 and 157) there is a pocket containing fragments of plants. On each sheet there are one to three specimens, all in good condition, except for two missing ones (on page 32 and page 65). They are always placed on only one side of the sheet (where they are glued with a strip of paper), and in many cases are made up of herbaceous plants, usually collected *in toto*. Often, for completeness, we find several specimens of the same *taxon*: either different parts of the same individual or the initial stage (which the author indicates as the "*exordium*").

As far as the nomenclature is concerned, in most cases on a strip of paper we find the name of the *taxon* (polynomial) in Latin, written very clearly and neatly. In the studied *herbarium* 122 *taxa* are present, all belonging to the angiosperms except one alga (Appendix 1). They belong to 43 families, of which the most diverse is the *Asteraceae* with 21 *taxa*, followed by the *Apiaceae* with nine *taxa*, the *Brassicaceae* and the *Caryophyllaceae* with seven each. The most represented genera are *Centaurea* and *Plantago* with four entities. Most of the *taxa* (72%) present in the *herbarium* under discussion are described and drawn in "*Icones et Descriptiones*" (Appendix 1). Of nine *taxa* pictured and described in the above-mentioned work the *herbarium* samples are missing.

On the basis of what Boccone himself wrote in "*Icones et Descriptiones*", 84% of the specimens come from Italian localities (for the most part Sicilian) and 16% from France and Malta (spontaneous *taxa*) or from French and Italian Botanical Gardens (exotic *taxa*). Regarding chorology, 52% of the *taxa* have a Mediterranean and steno-Mediterranean distribution. The endemic and subendemic element, which accounts for 32%, is striking.

In the BIUM *herbarium* we find the imprints of 38 samples of the Leiden *herbarium*. From the comparison (Figure 5) we conclude that:

- 8% are part of the first class of similarity (range 70–80%);
- 29% are part of the second class of similarity (range 81–90%);
- 63% are part of the third class of similarity (range 91–100%).

Among the specimens of the studied *herbarium* are present *types*, two of which are designated below, following McNeill et al. (2012):

1. *Daucus gingidium* subsp. *polygamus* (Gouan) Onno, Beih. Bot. Centralbl. 56 (B): 100. 1936.

Basionym: *Daucus polygamus* Gouan, Observ. Bot. III: 9, 1773.

Lectotype (designated here): iconography plate 40 figure III "Pastinaca Oenanthes folio" Boccone 1674:74. Epitype (designated here): "Pastinaca Oenanthes folio ex Sicilia" page 52 Leiden *Herbarium* (L) (Figure 6).

Notes: The figure III of Table 40 of "*Icones et Descriptiones*" (Boccone 1674) is indicated by Gouan in the protologue (1773) as the material he used to describe the aforementioned species, elevated successively by Onno (1936) to the subspecific rank. Therefore, Boccone's iconography is here designated as lectotype of *Daucus polygamus* Gouan. On page 52 of the Leiden Boccone *herbarium* there is a specimen of Sicilian origin that exactly matches the drawing (mirror image) of "*Icones et Descriptiones*". Therefore, this sample is here designated as epitype of *Daucus polygamus* Gouan. As regards the original locality, Boccone (1674) indicates "*Supra muros Leocatae Civitatis in Sicilia inveni*" (I found it on the walls of the small town of Licata in Sicily).

Table 1. Comparison between BIUM and Leiden images.

Taxa	Corresponding samples numbered progressively	Bium Boccone's herbarium sheet number	Leiden Boccone's herbarium sheet number	Correspondence (%)	Remarks
Astragalus boeticus L.	1/1	102	120	95	
Astrantia pauciflora Bertol.	1/3	96	14	95	The imprint is turned 90° clockwise with respect to the sample and is only part of it
Astrantia pauciflora Bertol.	2/3	96	15	93	The imprint is turned 90° clockwise with respect to the sample
Astrantia pauciflora Bertol.	3/3	96	15	92	The imprint is turned 90° clockwise with respect to the sample
Cachrys sicula L.	1/2	12	98	90	A part of the sample is broken and was glued on the same sheet
Cachrys sicula L.	2/2	17; 60 verso	97	90	The same imprint is found in two sheets. The sample lacks a portion; there is its trace on the sheet
Capparis ovata Desf.	1/4	22	107	97	The imprint is turned 90° clockwise with respect to the sample
Capparis ovata Desf.	2/4	22 verso	106	97	The imprint is turned 90° clockwise with respect to the sample
Capparis ovata Desf.	3/4	22 verso	106	96	The imprint is turned 90° clockwise with respect to the sample
Capparis ovata Desf.	4/4	22 verso	106	96	The imprint is turned 90° clockwise with respect to the sample
Desmazeria sicula (Jacq.) Dumort.	1/2	44	56	96	The imprint is turned 90° clockwise with respect to the sample
Desmazeria sicula (Jacq.) Dumort.	2/2	44	56	76	The imprint is turned 90° clockwise with respect to the sample. The sample is made up only of a portion of the entire specimen used for the imprint
Cheirolophus sempervirens (L.) Pomel	1/4	4	115	82	
Cheirolophus sempervirens (L.) Pomel	2/4	30	114	83	
Cheirolophus sempervirens (L.) Pomel	3/4	30	114	84	
Cheirolophus sempervirens (L.) Pomel	4/4	30	114	98	
Crypsis schoenoides (L.) Lam.	1/1	43	20	90	The sample is made up only of a portion of the entire specimen used for the imprint
Diplotaxis harra subsp. *crassifolia* (Raf.) Maire	1/2	3	17	81	
Diplotaxis harra subsp. *crassifolia* (Raf.) Maire	2/2	3	17	95	
Halimione portulacoides (L.) Aellen	1/1	41	11	90	
Helleborus sp.	1/1	99	161	98	The imprint is turned 180° clockwise with respect to the sample
Limonium bocconei (Lojac.) Litard.	1/3	119	144	88	
Limonium bocconei (Lojac.) Litard.	2/3	119	144	80	
Limonium bocconei (Lojac.) Litard.	3/3	119	144	90	
Linaria heterophylla Desf.	1/1	13	152	93	
Magydaris pastinacea (Lam.) Paol. & Bég.	1/2	9	100	94	In the sample there are missing portions; there are traces on the sheet
Magydaris pastinacea (Lam.) Paol. & Bég.	2/2	9 verso	100	96	The imprint is turned 90° clockwise with respect to the sample
Malope malacoides L.	1/2	31 verso	111	97	The imprint is turned 90° clockwise with respect to the sample and is its mirror image
Malope malacoides L.	2/2	31 verso	112	96	The imprint is turned 90° clockwise with respect to the sample
Parapholis incurva (L.) C. E. Hubb.	1/1	35 verso	43	98	
Pimpinella anisoides V. Brig.	1/1	49	7	98	
Plantago cf *coronopus* L. s.l.	1/1	122	27	97	
Plantago macrorrhiza Poir.	1/1	36 verso	81	81	The imprint is turned 90° clockwise with respect to the sample
Reaumuria vermiculata L.	1/2	47	135	95	The imprint is turned 90° clockwise with respect to the sample

(*Continued*)

Table 1. (*Continued*).

Taxa	Corresponding samples numbered progressively	Bium Boccone's herbarium sheet number	Leiden Boccone's herbarium sheet number	Correspondence (%)	Remarks
Reaumuria vermiculata L.	2/2	47	136	79	The imprint is turned 90° clockwise with respect to the sample
Solanum cf *paniculatum* L.	1/1	42	118	91	
Teucrium flavum L. subsp. *flavum*	1/2	97	8	95	
Teucrium flavum L. subsp. *flavum*	2/2	97	8	94	

Note: "Sample" is referred to Boccone's herbarium of Leiden; "imprint" is referred to Boccone's herbarium of BIUM.

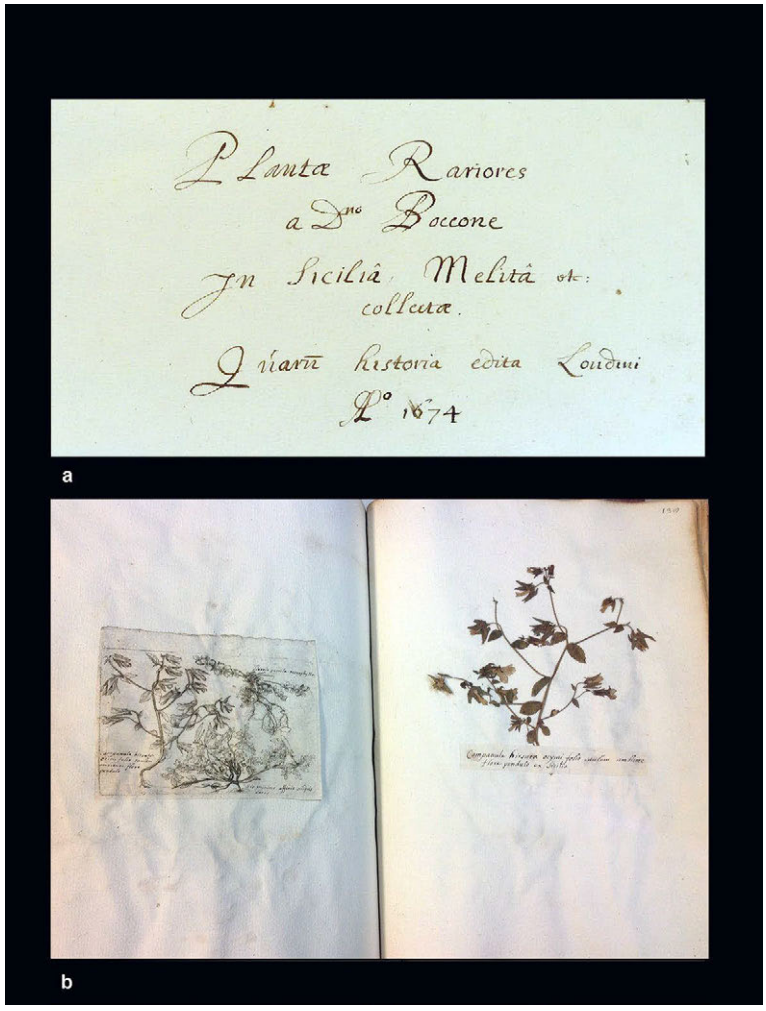


Figure 4. (a) Title-page; (b) sheet number 137 (verso) and 138 (recto) (Naturalis Biodiversity Center, Leiden, the Netherlands).

2. *Daucus carota* subsp. *commutatus* (Paol.) Thell, Repert. Spec. Nov. Regni Veg. 22: 312. 1926.

Basionym: *Daucus carota* var. *commutatus* Paol., Fiori et Paoletti Fl. Anal. Ital. II: 186, 1900.

Lectotype (designated here): iconography plate 14 figure II Me "Pastinaca tenuifolia Sicula, hirsuta, crispa" Boccone 1674:28 (sub Pastinaca hirsuta crispa Tenuifolia). Epitype (designated here): "Pastinaca hirsuta, crispa sicula" (sub eadem Pastinaca), right-hand specimen on page 60 of the Leiden *Herbarium* (L) (Figure 7).

Notes: Paoletti (in Fiori et Paoletti, 1900) indicates as a synonym of *Daucus carota* var. *commutatus*, described by him, *Daucus mauritanicus* sensu Bertoloni not Linneo. Bertoloni (Fl. Ital. III: 168, 1837) refers, as well as to Linnaeus (Sp. Pl. I (Ed 2): 348, 1762), aslo to Gussone (Suppl. Prodr. Fl. Sic. I: 73, 1832), who indicates Boccone's iconography (1674). Thellung (1926), on the basis of the basionym of Paoletti, proposes the subspecies referring to the drawing of "*Icones et Descriptiones*". Therefore, Boccone's iconography is here designated as lectotype of *Daucus carota* var. *commutatus* Paol.



Figure 5. (a) Sheet number 161 (recto) of L herbarium (Naturalis Biodiversity Center, Leiden, the Netherlands); (b) sheet number 99 of BIUM herbarium (http://www.biusante.parisdescartes.fr/boccone/); (c) comparison between the two images (Image Comparer™ 3.8 Build 713).

There are several samples of this species in the Boccone's *herbarium*: two on page 59, one of which (the right hand one) corresponds to figure II M of plate 14 (mirror image), and two on page 60, one of which (the right hand one) corresponds to Figure II Me of the same plate (mirror image). Probably it is two parts of the same individual, but as the sample of page 60 is complete with leaves and inflorescence, it is here designated as epitype of *Daucus carota* var. *commutatus* Paol. With regard to its original locality, Boccone (1674) indicates "Inter *Leocatam* & *Agrigentum* nascitur, in scopulo dicto *San Nicolo*" (It grows on cape San Nicola, between Licata and Agrigento).

Further studies on the typification of other samples in the Leiden Boccone *herbarium* are still ongoing.

Discussion and conclusions

The Boccone volume that has been studied, like all historical *herbaria*, is important for various reasons. First and foremost it makes a contribution to the diachronic analysis of vegetable biodiversity (Mazzoleni et al. 1992; Capotorti et al. 2012; Van Andel et al. 2012; Pulvirenti, Indriolo, et al. 2015; Costa, Pavone, Caruso et al. 2016; Pulvirenti et al. 2017b). It also contributes to the evaluation of the temporal changes in the floristic composition of a territory (Blasi et al. 2010, 2011, 2014; Danin et al. 2014; Giarrizzo et al. 2015). In addition, historical collections are useful for floristic, taxonomic and nomenclatural studies (Pimenov and Sutorý 2014; Iamonico and Managlia 2015; Iamonico and Sánchez-Del 2016; Ferrer-Gallego et al. 2017). The presence of type material is certainly of great importance. Boccone's drawings, thanks to the realistic fidelity that characterizes them, have been used by various authors for the description of *taxa* new for the science.

As regards taxonomic composition, the prevalence of angiosperms, which make up almost all the samples, is clear (Supplementary Table 1). They have all been identified except the two missing ones and the specimen on the last sheet, which is sterile (Appendix 1).

The collection under discussion has no dedicatory letter, which is usually found in the majority of Boccone's volumes of *exsiccata*. In addition, in some cases the same *taxon* is present in various growth stages. These elements lead us to conclude that it is a *herbarium* used for research and not one destined to be a gift, similar to the one kept in Catania (Pulvirenti et al. 2017b).

Even if the structure (dimension, binding, mounting method of the specimens, etc.) is similar, the correspondence between the *taxa* of the Catania *herbarium* and the Leiden one is limited: only 13 entities are common to both *herbaria*. This difference can be explained by the fact that the two volumes belong to different



Figure 6. (a) Sheet number 52 (recto) (Naturalis Biodiversity Center, Leiden, the Netherlands); (b) Table 40 (page 74) of "*Icones et Descriptiones*".



Figure 7. (a) Sheet number 60 (recto) (Naturalis Biodiversity Center, Leiden, the Netherlands); (b) Table 14 (page 28) of "*Icones et Descriptiones*".

periods of the author's life. The Catania *herbarium* belongs to the "Roman period", as it documents herborization activity in the centre and north of Italy: the plants come from high altitude zones in the Alps, Prealps and centre and north of the Apennines, where they could have been collected by Boccone around 1680 (the date on the title page). The Dutch *herbarium* was produced previously (ca. 1673), since it was used to print "*Icones et Descriptiones*" (1674) and consists of plants of different origins (Italy, France, Malta and Italian and French Botanical Gardens).

The presence on the back of 32 sheets of proofs of the engravings (cut and glued) corresponding to the plates of "*Icones et Descriptiones*", make this *herbarium* unique with respect to all the other *herbaria* produced by Boccone that are known to exist. The majority of the *taxa* present are described and pictured in the above-mentioned published volume. The author certainly used these samples for his drawings. Sometimes, although it is the same *taxon*, the sample is different from its depiction; in some cases the names are missing and some engravings are duplicated (Supplementary Table 1). The missing entities (or those which are depicted in a different way) could be those present in the Paris *herbarium* (Bonnet 1883) or in the Vienna one (Lack 2003).

Some specimens from the volume under discussion, which show visible traces of ink, could have been used previously to produce the imprinted *herbarium* that is kept in the BIUM in Paris. The biographical data concerning Boccone's travels in Europe support this hypothesis. His presence at Chantilly in 1671, as a guest of the Prince of Condé (1621–1686), and then in Leiden in the years immediately after is confirmed by precise documentary references: the signed title page of the "Cahier de Chantilly", dated 20 October 1671 and a letter signed by Boccone and written to Heinsius (1620–1681), kept in the Leiden University Library, dated 1 October 1673 (Figure 8).

From the comparison (Table 1) it has emerged that in the BIUM *herbarium* we find the imprints of 38 samples of the Leiden *herbarium*, even if the *taxa* common to the two *herbaria* are more numerous. In fact, some specimens (such as *Bignonia capreolata* L., *Cyperus papyrus* subsp. *siculus* (Parl.) Chiov. ex Kiikenthal, *Eryngium tricuspidatum* subsp. *bocconei* (Lam.) Wörz, *Heliotropium suaveolens* subsp. *bocconei* (Guss.) Brummitt, etc.) are present in both collections, but the imprints do not correspond to the samples. Among the images singled out as corresponding (in the sense that the specimens were used by Boccone first for the imprints and then to realize the *herbarium*) we have not observed a percentage of similarity higher than 98%. This is due to a number of factors: parts of the samples are covered with strips of paper used for mounting, there is a different quality of the images which do not allow a perfect overlap of the pixel, and some samples have deteriorated and lack of fragments (and/or solid parts) with respect to the imprint.

The comparison between the imprinted *herbarium* in Paris, the one in Leiden and the volume entitled "*Icones et Descriptiones*" allows us to verify Boccone's experimental innovations and to evaluate the complex problems of botanical representation that were faced by pre-Linnaean scholars. Boccone was aware of the inadequacy of the *herbaria picta*, in which the graphic representation was the result of the free interpretation of the author, according to his capacity of observation, his taste, and his ability as a drawer. He experimented with the techniques of the *horti impressi*, realized by means of ink or lamp soot. He reproduced with drawings the imprints that he had made. The objective was

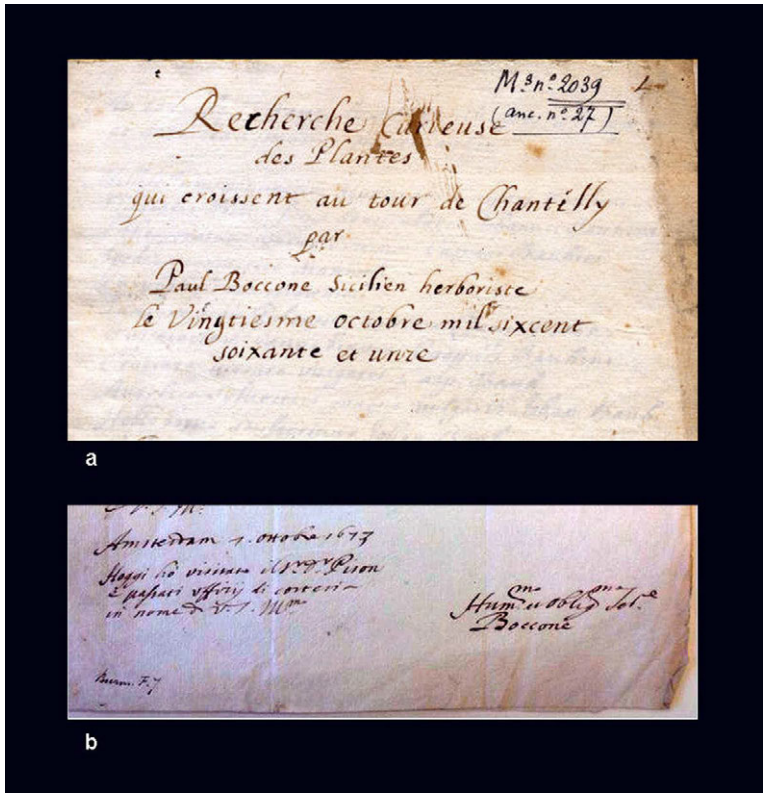


Figure 8. (a) Detail of the sheet number 1 of BIUM herbarium (http://www.biusante.parisdescartes.fr/boccone/); (b) detail of the letter from Boccone to Heinsius (Leiden University Library, Leiden, the Netherlands).

to reconcile the need for realistic representation of plants with the need for widespread dissemination of scientific results, which was made possible by the evolution of printing techniques (Zucchi 2001).

His research aimed at objectivity and realism in scientific representation. His life story is a witness to this. His journeys and stays following his Florentine experience (which ended around 1653) reveal a scientific and methodological ferment, which induced Boccone to experiment with new techniques and to measure himself against contemporary botanists in the principal cultural capitals of his time.

The method that emerges from the links between the three works we have examined (it was no coincidence that they were produced during the various phases of his travels) was that of arriving at the printing of botanical material as objective and realistic as possible. The plant was collected, exsiccated, dipped in ink, reproduced on paper by means of imprinting, drawn and, finally, engraved on a copper plate to be printed.

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No potential conflict of interest was reported by the authors.

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Appendix 1. Taxonomic index with the corresponding plates no. (page no.) of "*Icones and Descriptiones*" on which the sample is drawn

Achillea tenuifolia Lam. **3 (5)**
Achyranthes sicula (L.) All. **9 (17)**
Aconogonon alpinum (All.) Schur
Aegonychon purpurocaeruleum (L.) Holub **40 (74)**
Allium siculum Ucria **33 (63)**
Ambrosina bassii L. **26 (51)**
Andropogon distachyos L. **11 (20)**
Apocynum androsaemifolium L. **16 (32)**
Aristolochia sicula Tineo **3 (5)**
Astragalus boeticus L. **4 (7)**
Astrantia pauciflora Bertol. **5 (9)**
Atriplex littoralis L. **15 (30)**
Biarum tenuifolium (L.) Schott **42 (78)**
Bignonia capreolata L. **15 (30)**
Biscutella lyrata L. **23 (46)**
Cachrys sicula L. **18 (37)**
Campanula dichotoma L. **45 (84)**
Campanula garganica Ten. **27 (54)**
Capparis ovata Desf. **42 (78)**
Cardamine asarifolia L. **3 (5)**
Cardamine graeca L. **45 (84)**
Catananche lutea L.
Centaurea melitensis L. **35 (65)**
Centaurea cf *melitensis* L.
Centaurea panormitana subsp. *ucriae* (Lacaita) Greuter
Centaurea sicula L. **8 (15)**
Cerastium cf *arvense* L. **12 (23)**
Ceratocephalus falcatus (L.) Pers. subsp. *falcatus* **14 (28)**
Cheirolophus sempervirens (L.) Pomel **39 (72)**
Chiliadenus bocconei Brullo **13 (25)**
Citrus × *aurantium* L. **2 (3)**
Convolvulus cneorum L.
Convolvulus siculus L. **48 (89)**
Crassula tillaea Lest.-Garl. **29 (56)**
Crassula vaillantii (Willd.) Roth **25 (49)**
Crypsis schoenoides (L.) Lam.
Cyperus papyrus susbp. *siculus* (Parl.) Chiov. ex Kiikenthal
Datura ferox L. **26 (51)**
Daucus carota subsp. *commutatus* (Paol.) Thell. **14 (28)**
Daucus gingidium L. susbp. *polygamus* (Gouan) Onno **40 (74)**
Daucus sp.
Desmazeria sicula (Jacq.) Dumort. **33 (63)**
Diplotaxis harra subsp. *crassifolia* (Raf.) Maire
Dittrichia viscosa (L.) Greuter **7 (13)**
Dracocephalum cf *virginianum* L. **6 (11)**
Eragrostis cilianensis (All.) Janch.
Erigeron canadensis L. **46 (86)**
Eryngium tricuspidatum subsp. *bocconei* (Lam.) Wörz **47 (88)**
Euphorbia akenocarpa Guss. **19 (38)**
Euphorbia falcata L. **13 (25)**
Euphorbia pithyusa L. **5 (9)**
Fumana ericifolia Wallr.
Galium scabrum L. **6 (11)**
Galium sp. **45 (84)**
Glandora rosmarinifolia (Ten.) D. C. Thomas **41 (76)**
Glinus lotoides L. **11 (20)**
Halimione portulacoides (L.) Aellen
Helianthus strumosus L. **27 (53)**
Heliotropium suaveolens subsp. *bocconei* (Guss.) Brummitt **49 (91)**
Helleborus sp.
Iberis semperflorens L. **29 (56)**
Inula brittannica L.
Inula verbascifolia (Willd.) Hausskn.
Isolepis setacea (L.) R. Br. **20 (41)**
Jacobaea delphiniifolia (Vahl) Pelser & Veldkamp **51 (94)**
Limoniastrum monopetalum (L.) Boiss. **16 (32); 17 (33)**
Limonium bocconei (Lojac.) Litard. **34 (64)**
Limonium pseudominutum Erben **13 (25)**
Limonium zeraphae Brullo **44 (83)**
Linaria heterophylla Desf. **19 (38)**
Linaria simplex (Willd.) DC.
Linaria triphylla (L.) Mill. **22 (45)**
Magydaris pastinacea (Lam.) Paol. & Bég. **1 (2)**
Malope malacoides L. **8 (15)**
Malva agrigentina (Tineo) Soldano, Banfi & Galasso **37 (68)**
Matthiola tricuspidata (L.) W. T. Aiton
Micromeria graeca susbp. *fruticulosa* (Bertol.) Guinea
Missing sample **12 (23)**
Missing sample **2 (3)**
Nepeta tuberosa L. **25 (49)**
Ononis fruticosa L.
Ononis variegata L. **38 (70)**
Origanum onites L.
Osmundaria volubilis (Linnaeus) R.E.Norris **38 (70)**
Parapholis incurva (L.) C. E. Hubb.
Parietaria judaica L. **24 (47)**
Parietaria lusitanica L. **24 (47)**
Paronychia echinulata Chater **20 (41)**
Phagnalon rupestre (L.) DC. subsp. *rupestre*
Phyteuma hedraianthifolium Rich. Schulz **42 (78)**
Pimpinella anisoides V. Brig.
Plantago afra L. **4 (7)**
Plantago cf *coronopus* L. s.l. **38 (70)**
Plantago macrorrhiza Poir. **15 (30)**
Plantago subulata L.
Podospermum laciniatum (L.) DC. **7 (13)**
Polycarpon tetraphyllum subsp. *diphyllum* (Cav.) O. Bolòs & Font Quer **38 (70)**
Pulicaria sicula (L.) Moris **31 (60)**
Reaumuria vermiculata L. **4 (7)**
Reseda alba L.
Reseda lutea L. **41 (76)**
Rhamnus cathartica L.
Rhodalsine geniculata (Poir.) F. N. Williams **10 (18)**
Rubia peregrina L.
Rubia tinctorum L.
Rubus sp. **39 (72)**
Salsola verticillata Schousb. **31 (60)**
Sanguisorba officinalis L.
Searsia pentaphylla (Jacq.) Moffett **21 (43)**
Senecio gallicus Will. 41 (76)
Senecio squalidus susbp. *chrysanthemifolius* (Poir.) Greuter **36 (67)**
Seseli bocconi Guss. **27 (53)**
Sida rhombifolia L. **6 (11)**
Silene coeli-rosa (L.) Godr. **14 (28)**
Silene fruticosa L. **30 (58)**
Silene sedoides Poir. **12 (23)**
Solanum cf *paniculatum* L.
Solanum tomentosum L. **5 (9)**
Solidago cf *flexicaulis* L.
Stuckenia cf *pectinata* (L.) Börner **20 (41)**
Teucrium flavum L. susbp. *flavum*
Thymbra capitata (L.) Cav.
Thymelaea tartonraira (L.) All. subsp. *tartonraira*
Verbascum blattaria L. **31 (60)**
Zea mays L. **16 (32)**