Goethe's botany : the Metamorphosis of plants (1790) and Tabler's Ode to nature (1782) / with an introduction and translations by Agnes Arber.

Contributors

Goethe, Johann Wolfgang von, 1749-1832.
Tabler, Georg Christoph, 1757-1812.
Arber, Agnes, 1879-1960.

Publication/Creation

[Waltham, Mass.], [1946]

Persistent URL

https://wellcomecollection.org/works/jv59j49r

License and attribution

Wellcome Collection
183 Euston Road
London NW1 2BE UK
T +44 (0)20 7611 8722
E library@wellcomecollection.org
https://wellcomecollection.org

ARBER

HIST. PAM.

Chronica Botanica, Volume 10, Number 2

AGNES ARBER, D.Sc., F.R.S.

Author of 'Herbals', 'Water Plants: A Study of Aquatic Angiosperms', 'Monocotyledons: A Morphological Study', 'The Gramineae: A Study of Cereal, Bamboo, and Grass', etc.

GOETHE'S BOTANY

Single copies of this number $2.00

Issued Summer 1946

the Chronica Botanica Co., Waltham, Mass., U.S.A.

New York City, G. E. Stechert and Co.; San Francisco, J. W. Stacey, Inc.; Ottawa, Thorburn and Abbott, Ltd.; México, D. F., Axel Moriel Sucrs.; Bogotá and Medellín, Libreria Central; Lima, Libreria Internacional del Peru; Santiago de Chile, Libreria Zamorano y Caperan; Rio de Janeiro, Livraria Kosmos; São Paulo, Livraria Civilização Brasileira; Buenos Aires, Acme Agency; London, Wm. Dawson & Sons, Ltd.; London, H. K. Lewis and Co., Ltd.; Uppsala, A. B. Lundequistska Bokh.; Groningen, N. V. Erven P. Noordhoff; Paris, Librairie H. Le Soudier; Torino, Rosenberg & Sellier; Lisbon, Livraria Sá da Costa; Moscow, Mezhdunarodnaja Kniga; Calcutta, Bombay and Madras, Macmillan and Co., Ltd.; Johannesburg, Central News Agency, Ltd.; Sydney, Angus and Robertson, Ltd.; Melbourne, N. H. Seward, Pty., Ltd.

N. xiv.

CHRONICA BOTANICA, An International
Collection of Studies in the Method and History
of Biology and Agriculture, edited by FRANS VERDOORN
• Volume 10, Number 2, Pages 63-126, Plates 23-26 •
(*Issued Summer* 1946)

GOETHE'S BOTANY

Goethe's Garden House ("Gartenhaus am Stern"), after a drawing by Georg Melchior Kraus, from Neubert (1919): "Goethe und sein Kreis," Leipzig.

GOETHE'S BOTANY

The METAMORPHOSIS *of* PLANTS (1790)

and

TOBLER's ODE *to* NATURE (1782)

With an introduction and translations

by

AGNES ARBER, D.Sc., F.R.S.

Author of 'Herbals', 'Water Plants: A Study of Aquatic Angiosperms', 'Monocotyledons: A Morphological Study', 'The Gramineae: A Study of Cereal, Bamboo, and Grass', etc.

Printed in the United States of America

CONTENTS

PLATES and ILLUSTRATIONS

Introduction[1]**:** — The botanist who attempts to study GOETHE's scientific work, finds himself dealing merely with one facet of a mental life unexampled in its many-sidedness. This one facet is so completely integrated with GOETHE's general productivity, that it cannot be understood except in connexion with the whole; but to see it thus in perspective demands an acquaintance not only with his own vast output of writings, letters, and recorded speech, but also with the immense corpus of GOETHE scholarship. This can scarcely be compassed by any man of science outside Germany.[2] Another difficulty with which the student of GOETHE's botany is faced at the outset, is that those scholars who have the fullest and most critical knowledge of his writings, differ radically in their estimate of his science, both in its relation to his work in general, and when considered in itself. At one

1. Throughout this Introduction the references to GOETHE's writings are given either from GOETHE, J. W. VON (1887 etc.): *Werke herausgegeben im Auftrage der Grossherzogin* SOPHIE VON SACHSEN, Weimar (cited here as Sophien-Ausgabe), or from TROLL, W. (1926): *Goethes Morphologische Schriften*, Jena (cited here as TROLL ed.; when, however, the reference is not to GOETHE's writings, but to TROLL's own introductory matter, the book is cited as TROLL, W. (1926)); or from the German part of GOETHE, J. W. VON (1831): *Versuch über die Metamorphose der Pflanzen. Übersetzt von* F. SORET, *nebst geschichtlichen Nachträgen*. Stuttgart (cited here as SORET ed.).

2. The references to the literature in the present Introduction have been limited by the inaccessibility of modern German work under the present conditions; I have not, for instance, been able to see SCHMIDT, G. (1940): *Goethe und die Naturwissenschaften*, pp. 618, Halle. To this bibliographical work, and to other titles, Dr. VERDOORN has kindly called my attention.

extreme we have authorities, such as J. G. ROBERTSON, who speaks with regret of the large share that science took in GOETHE's activities, and who voices the doubt whether his scientific interests "were not as real a crime against the majesty of his poetic genius as his immersion in the routine of state government"[3]; and Sir CHARLES SHERRINGTON, who remarked in a recent lecture: "Were it not for GOETHE's poetry, surely it is true to say we we should not trouble about his science[4]". At the other end of the scale stands W. TROLL, who maintains, in a fully reasoned study of GOETHE's morphology, that the centre and focal point of his whole mental life is to be sought in his scientific writings[5]. We meet with the same conflict of opinion when the value of GOETHE's scientific work is assessed in itself, rather than in relation to his general output. SHERRINGTON, for instance, dismisses the metamorphosis idea as "no part of botany today", and adds that "GOETHE's view has gone the way of unsupported theories[6]"; on the other hand, TROLL — a botanist—ascribes to him the credit of having actually founded the science of morphology, the name of which he invented[7].

GOETHE himself was very far from considering his work in natural science as a mere side issue of his career as a poet. In old age, when reviewing his past, he declared that a great part of his life had been devoted to science, not only with inclination and with passion, but also with consistent effort; and he definitely claimed to be estimated seriously as a scientific worker[8]. Whether, with ROBERTSON, we should regard GOETHE's science as a grievous lapse, or, with TROLL, as one of the fertilising sources of his creative life, or whether a somewhat different type of appraisement is needed, will become apparent after we have reviewed the botanical aspect of his work, and the tendencies of his thought in biological matters.

GOETHE's childhood and youth were passed in towns, and it was not until he went to Weimar that vegetation came prominently under his eye; for there he found himself in the midst of fields and gardens, while hunting —a favourite pastime of the court—led him into the Thuringian forests. His responsible concern for everything local made him interest himself in the technique of forestry, which had been brought to a high pitch in the duchy. Moreover, owing to the Duke's amicable relations with his neighbours, even those forests which lay outside his boundaries were freely open to GOETHE. In this woodland country, which he came to know intimately, he made acquaintance with the herbalists to whom the apothecaries in the towns owed their supplies. These herbalists made all kinds of medicinal extracts, handing on their secret recipes from father to son. It was under their auspices that he learned to know, in particular, the different kinds of gentian, which were valued for the curative properties of the root; this was

3. ROBERTSON, J. G. (1932): *The Life and Work of Goethe. 1749-1832.* London. pp. 312 and 97.
4. SHERRINGTON, C. (1942): *Goethe on Nature and on Science.* Cambridge, England; p. 23.
5. TROLL, W. (1926): *l.c.*, p. 5.
6. SHERRINGTON, C. (1942): *l.c.*, p. 21.
7. TROLL, W. (1926): *l.c.*, p. 7.
8. SORET ed.: *Nachträge und Zusätze*, I. *Der Verfasser theilt die Geschichte seiner botanischen Studien mit.* Pp. 107-63 (German and French version). Our knowledge of GOETHE's botanical history is largely derived from this piece of autobiography, which is to be found also in TROLL ed., pp. 187-209.

the first genus in which he studied specific distinctions. In retrospect GOETHE took pleasure in the analogy between his personal botanical history, and the history of botany in general; for his interest was first aroused by practical considerations, and it was only gradually that he came to be attracted by the subject in its theoretical aspect. GOETHE's botanical tastes were stimulated especially by contact with a remarkable family—the DIETRICHS of Ziegenhain[9]—amongst whom, through a series of generations, a passion for botany asserted itself again and again. In 1688 a certain SALOMO DIETRICH, an exile from Bohemia for religion's sake, had fled to Thuringia, where he took a farm. In 1711 a son ADAM was born to him. ADAM succeeded his father in the farm, and one of his undertakings was to send weekly supplies of plants, for botanical purposes, to the University of Jena. He became well known as the Ziegenhain "Botanicus"; he treasured a letter written to him by LINNAEUS with his own hand—a document which he honoured as a patent of botanical nobility. Love of plant study extended to the fourth generation from ADAM DIETRICH; his great-grandson, A. W. S. DIETRICH, made and sold herbaria, and trained his wife, a village girl of Saxony, in all the necessary technique. Though not a DIETRICH by birth, she proved to have a supreme flair for field work, and she is remembered for the adventurous and solitary years she spent in North Australia, collecting for GODEFFROY; she lived into the last decade of the nineteenth century. The member of the family, who was specially associated with GOETHE, was AMALIE's uncle by marriage, F. GOTTLIEB DIETRICH, born in 1768. GOETHE met him in the seventeen-eighties, and was so much pleased with his knowledge of Linnean botany, and his ecstatic happiness in it, that he took him as a companion when he went to Carlsbad for a cure. On the journey, GOTTLIEB searched for plants, bringing them to GOETHE's travelling carriage, while proclaiming their Latin names like a herald. When GOETHE had settled at the spa, GOTTLIEB was away among the mountains by sunrise, hunting for flowers, and was able to bring the spoils to GOETHE before he had finished his morning draught of the waters.

For a time, GOETHE remained wholly devoted to the Linnean system, giving himself up to it with absolute confidence. As books which he was constantly studying, he names LINNAEUS' *Fundamenta botanica, Termini botanici,* and *Elementa botanica,* and also JOHANN GESSNER's *Dissertationes.* The latter work, which explained the principles of LINNAEUS, was published under his aegis[10]. Even when GOETHE had lived through the first ardour of enthusiasm for studies of this type, and had published refutations of certain erroneous views held by LINNAEUS[11], he still retained a reverence for the master himself, but the nature of this reverence has sometimes been

9. BISCHOFF, C. (1931): *The Hard Road: The Life Story of Amalie Dietrich.* Translated by A. LIDDELL GEDDIE. London. (C. BISCHOFF is the great-great-granddaughter of ADAM DIETRICH, on whom *see* BENEDIKT, E. (1945): *Goethe und Linné.* Svenska Linné-Sällskapets Årsskrift, 28, pp. 49-54; this paper appeared after the present Introduction was in print.)

10. The title is GESNER (GESSNER), J. (1743): *Dissertationes physicae de vegetabilibus. Quarum prior partium vegetationis structuram, differentias et usus, posterior vero partium fructificationis structuram differentias, ac usus sistit. In quibus elementa botanica Celeb. Linnaei dilucide explicantur.* (Printed with LINNAEUS, C. (1743): *Oratio de necessitate peregrinationum intra patriam.* Lugduni Batavorum.)

11. *See* p. 76.

misunderstood by GOETHE students, and its degree exaggerated, on the strength of a sentence in a letter to ZELTER, written on November 7, 1816[12]. He says, speaking of LINNAEUS, "Except SHAKESPEARE and SPINOZA, I am not aware that any man of the past has had such an influence upon me." This is, at first sight, a startling remark, for it is impossible to believe that a man of GOETHE's mental calibre could have ranked LINNAEUS actually with either SHAKESPEARE or SPINOZA. A careful reading of this and preceding letters sets the matter, however, in a different light; for it becomes clear that GOETHE's words do not relate to these three men, appraised in themselves, but merely in their effect upon his own personal development, an effect depending largely on his individual circumstances. It is important to notice that, in the letter just cited, he avows that, though he has learned an infinite amount from LINNAEUS, what he has learned has not been botany. In the previous month[13] he had told ZELTER that a return to the study of LINNAEUS, many years after he first came to know his work, had brought him to recognise that he has used the Swedish master in symbolic fashion only; that is to say, he has sought to transfer LINNAEUS' method and mode of treatment to other subjects, thus gaining an efficient mental instrument. We have to remember that GOETHE had undergone no explicit training in scientific discipline, and that he apparently knew little about pre-Linnean plant study. His tendency was to regard the whole corpus of systematically-developed biological thought as being the outcome of the genius of LINNAEUS alone. This attitude, which was very common in those days, was condemned by BATSCH, a botanist with whom GOETHE was acquainted[14]. BATSCH greatly admired LINNAEUS, but, in a book published in 1787, he protested against the injustice of exalting him at the expense of the many other writers who, in the eighteenth century, had promoted the knowledge of plants[15]. We can completely understand GOETHE's share in this overestimate, when we consider his intellectual history. When he first read LINNAEUS' writings, they supplied what was his crying need at that stage—an objective and scientifically methodical approach to botany; none of his previous studies in literature, law, or art, had been able to do him this particular service.

Despite the fervour with which, in his earlier pursuit of plant science, he had followed LINNAEUS, nothing could make detailed systematic botany really native to GOETHE. Although, stimulated by GOTTLIEB DIETRICH, he learned something of the application of the Linnean system in the field, he came gradually to the conclusion that the minute analysis and counting of the floral parts, which it involved, were not in his line: "Trennen und Zählen lag nicht in meiner Natur". At that date, when optical aids were not as advanced as they are today, a disinclination for the study of small objects must often have arisen simply out of visual difficulties; but, in GOETHE's case, the reaction against such occupations seems to have been

12. *Goethes Briefe.* Sophien-Ausgabe, Abth. IV, Bd. 27, p. 219.
13. *Goethes Briefe, l.c.*, p. 200, Oct. 14, 1816.
14. For an account of BATSCH, and his relations with GOETHE, *see* HANSEN, A. (1907): *Goethes Metamorphose der Pflanzen.* (2 pts. Text and Plates). Giessen. Chapter VII.
15. BATSCH, A. J. G. C. (1787): *Versuch einer Anleitung zur Kenntniss und Geschichte der Pflanzen.* Halle; *see* p. 8.

primarily a deep-seated mental one. He himself contrasts the way of studying Nature which consists in proceeding analytically into the individual particulars, with that which consists in following the clue holistically through breadth and height[16]; it was to the latter method that his limitations as well as his powers inclined him. He realised that the devotion of a lifetime, and aptitudes of a special order, were necessary for comprehensive and intensive systematic work, and he held that for him there was another way, more in keeping with the rest of his course through life, namely the contemplative study of the phenomena of change and mutation in the organic world — phenomena which had created a deep impression upon his mind[17]. In process of time the systematic aspect of botany seems, indeed, to have lost its appeal for him altogether. Late in life he wrote that Nature has no system, but that "she is the transition from an unknown centre to a limit which is not discernible", and that "Natural System" is thus a contradiction in terms[18]. Even in the earlier period, when GOETHE's ideas about biology were in their plastic phase, he was not alone in feeling a certain dissatisfaction with the way in which systematics, in the Linnean sense, had come to dominate botany. HEDWIG, a writer with whose work GOETHE was acquainted, pointed out in 1781 that plant study had been too much concerned with the examination of new material from all parts of the world, and with detailed descriptive work, to give much consideration to the "inner economy" of the plant on which all depends[19]. It was this "inner economy", and the morphological signs through which it expresses itself externally, on which GOETHE's interest was finally concentrated. He could not however have thrown light upon this aspect of the subject but for his earlier apprenticeship in looking closely at plants for the purpose of detecting their taxonomic marks. His practice in handling them impressed him with the contrast between the inevitable rigidity of the classificatory system, and the versatility of the organs themselves. Certain plants, for instance, came to his notice in which the same stem bore a *crescendo* series of leaves, of which the earliest were entire, and the next lobed, while an ultimate, almost compound-pinnate shape was succeeded by a *diminuendo* series of simplified forms, gradually reducing to small scales, and thence to nothing. The systematic botany of the period paid little attention to the plasticity of leaf structures, and GOETHE was unable at first to find any clue to the part which these transformations played in the general scheme of things. It was his journey into Italy, with the sight which it yielded him of a flora, both wild and cultivated, which was rich to a degree undreamed of in his more northerly home, and to which his mind was not deadened by familiarity, that finally set in motion a train of ideas which was to dominate his conception of the plant world for the rest of his life. A glimpse of the southern vegetation which so delighted him is revealed in his sketch of fig tree and maize.

One of his crucial experiences was his visit to the botanical garden at

16. *Probleme,* TROLL ed., p. 221.
17. *Entstehen des Aufsatzes über Metamorphose der Pflanzen.* TROLL ed., p. 208.
18. *Probleme,* TROLL ed., p. 221.
19. HEDWIG, J. (1781): *Vom waren Ursprunge der männlichen Begattungswerkzeuge der Pflanzen.* Leipziger Mag. zur Naturkunde, Math. und Oecon. (Leipzig und Dessau), pt. III, pp. 257-319; *see* p. 299.

Padua. Here he saw a palm, *Chamaerops humilis* L., from which he collected a series of leaves, ranging from early lanceolate forms, up to the mature fan, and then, by a sudden transition, to the spathe enclosing the inflorescence. These leaves he carefully preserved, and, thirty years later, he confessed to still regarding them as fetiches, because of the way in which they had arrested his attention at a critical juncture. The botanical garden at Padua has the longest history of any in Europe, having been founded in 1542, and GOETHE's palm, which still flourishes,[20] is said to date from as long ago as 1584. Though his suite of palm leaves set GOETHE pondering, it did not give him immediate illumination; this came after, in April 1786, he reached Sicily—the ultimate goal of his travels—and during his return journey to Rome[21]. The conviction of the original identity (ursprüngliche Identität) of all the members of the plant then became explicit in his mind. The *Versuch die Metamorphose der Pflanzen zu erklären*[22], published in 1790—the year in which GOETHE was forty-one—is the reasoned outcome of the meditations which began to take shape beside the palm tree at Padua. GOETHE realised, in the first place, the identity of the various forms of foliage leaf and bract, and then extended this conception to the parts of the flower. It was by no means the first time that ideas of this kind had occurred to botanists; to equate at least the outer members of the flower with leaves, has, indeed, always been natural to any acute observer. In the fourth century before CHRIST, THEOPHRASTUS had used the word 'leaf' (τὸ φύλλον) for the corolla[23]. Some 2000 years later, NEHEMIAH GREW[24] gave excellent anatomical reasons for considering sepals and petals as equivalent to foliage leaves, and—as regards the sepals—he called in also the evidence of abnormal forms. GREW's contemporary, MARCELLO MALPIGHI, again, described and figured the intermediates which may occur between petals and stamens in the rose[25]. These seventeenth-century anticipations were somewhat fragmentary, but, in 1768, more than twenty years before the publication of the *Metamorphose*, C. F. WOLFF[26] made a remarkably complete though brief statement of views closely related to those which GOETHE afterwards developed. WOLFF wrote that in some plants it is obvious that the calyx is a collection of relatively small and imperfect leaves, and that the pericarp is no less evidently composed of true leaves, which are, however, united. Petals and stamens, also, are *folia modificata*. Transitions between sepals and petals can be observed, and, in flowers with numerous stamens, these often degenerate into petals[27]. GOETHE was un-

20. Information by letter from Professor G. GOLA, Sept. 14, 1945.
21. TROLL, W. (1926): *l.c.*, p. 52.
22. Throughout this Introduction, this work, of which a translation follows (pp. 88-115), will be cited as *Metamorphose*.
23. THEOPHRASTUS (1916): *Enquiry into Plants*. Translated by Sir A. HORT, London. I.xiii.2; vol. I, p. 90.
24. GREW, N. (1672): *The Anatomy of Vegetables Begun*. London; *see* pp. 129-32, etc., discussed in ARBER, A. (1942): *Nehemiah Grew (1641-1712) and Marcello Malpighi (1628-1694)*. Isis, vol. 34, pp. 7-16; *see* p. 12.
25. MALPIGHI, M. (1675): *Anatome Plantarum*. London; p. 46 and pl. 28, fig. 160, "mixtura staminis et folii."
26. For details of WOLFF's career, and a critical appreciation of his work, *see* KIRCHHOFF, A. (1867): *Die Idee der Pflanzen-Metamorphose bei Wolff und bei Goethe*. Berlin.
27. WOLFF, C. F. (1768): *De formatione intestinorum*. Novi Commentarii Acad. Scientarum Imperialis Petropolitanae, vol. 12, pp. 403-507; *see* pp. 404-6.

acquainted with WOLFF's work when he wrote the *Metamorphose;* at that time, indeed, his knowledge of the relevant botanical literature was far from complete. He had no conception of the modern code according to which the scientist is under an obligation to read all that has been published on any problem before putting forward a solution of it as being his own. On the contrary, GOETHE undoubtedly felt himself entitled to full credit for any notions, which he had himself evolved without conscious borrowing, even if others happened to have expressed them before. He maintained[28] that the savant should use his predecessors' work without indicating his sources at every turn, although he ought to express his gratitude to those benefactors who have unlocked the world for him. Despite GOETHE's keen desire to be regarded by professional workers as a fellow scientist, the technique of his approach remained essentially that of the literary man, who is not expected to give a detailed enumeration of his sources in, for instance, a poem or a play. The *Metamorphose* must be judged, not as if it were a modern scientific treatise, but as a presentation of a nexus of ideas, much of the material for which was already in existence. These ideas GOETHE alone succeeded in developing into a unified organic whole, by adjusting them to the living framework of his thought, and thus creating one of the minor classics of botany[29]. It has been claimed that, on his Italian journey, his passion for the scientific study of nature closed with and worsted his creative instinct[30]; but such a view cannot be accepted by those who hold that creative insight can find its play in morphology as well as in poetry. It is this very quality which has given GOETHE's botanical work its permanent life.

GOETHE met with some difficulty in connexion with the appearance of the *Metamorphose* in book form[31]. His regular publisher, GOESCHEN, declined it, but ETTINGER of Gotha produced it in 1790; as GOETHE himself notes with satisfaction, it was beautifully printed in Roman type. The title-page is shown in facsimile on p. 88. A reprint, not identical in format, was issued by ETTINGER in the same year[32]. On casually turning over the pages of the *Metamorphose,* one may get a somewhat *staccato* impression, since it consists of a series of 123 short numbered paragraphs, which in the first edition were spaced rather far apart; these paragraphs are grouped into eighteen Parts. The sense, however, tends to run on without a break even from Part to Part. Extreme examples are the transition from the end of Part III to the beginning of Part IV, which opens, "This (dieses) seems still more probable"—"This" being inexplicable without reference to

28. *Meteore des literarischen Himmels. Plagiat.* Sophien-Ausgabe, Abt. II, Bd. 11, p. 252.

29. For a detailed review of the history and influence of GOETHE's ideas, *see* WIGAND, A. (1846): *Kritik und Geschichte der Lehre von der Metamorphose der Pflanze.* Leipzig. In reading this book, allowance must be made for its date, and for the fact that WIGAND's turn of mind was laborious rather than illuminating. Some criticisms of WIGAND's work will be found in KIRCHHOFF, A. (1867): *l.c.*

30. BUTLER, E. M. (1935): *The Tyranny of Greece over Germany.* Cambridge, England; p. 113.

31. *Schicksal der Handschrift.* TROLL ed., pp. 211-2.

32. On the editions *see* HANSEN, A. (1907): *l.c.,* p. IX. Those who wish for a modern reprint will find the one in TROLL ed. valuable, as it is beautifully illustrated with early, and also with new, figures.

Part III; or the transition from the end of Part X to the opening of Part XI, which begins, "On the contrary", (Dagegen), thus carrying on the argument continuously from the preceding Part. Paragraph 92, also, may not be understood unless it is recognised that it is an abstract of the conclusions of GAERTNER, to which reference has been made in the previous paragraph.

The word *Metamorphose,* in the title of GOETHE's book, was not altogether a happy one for his purpose. From classical times it had had poetical associations, which might well lead the reader to expect a work of fancy rather than of science, especially when the author was already famous for his imaginative writing. GOETHE himself complains that, on telling one of his friends that he had published a little volume upon the metamorphosis of plants, the friend expressed his delight in the prospect of enjoying GOETHE's charming description in the Ovidian manner of narcissus, hyacinth and daphne[33]. There was also a certain confusion inseparable from the term metamorphosis, because it had been not only used in describing the life history of insects, but had, in addition, been taken over by LINNAEUS into botany, in a sense different from that of GOETHE; LINNAEUS employs it in connexion with the change from the vegetative to the flowering phase, which he seems to have regarded as analogous to the change from the caterpillar stage to that of the perfect insect[34].

Apart from these questions of accepted usage, the term metamorphosis was not in itself exactly applicable to the events with which GOETHE dealt. As JAEGER[35] pointed out in 1814, the expression cannot be more than symbolic, since we do not, as a rule, witness an actual process of transformation; to say that any organ, as we know it, has been "transformed", is thus merely a figure of speech. The term metamorphosis can only denote a change which we imagine happens in the formative force (Bildungskräfte), rather than anything detectable in the visible members, though it is from the observed differences in the visible members that we deduce the existence of this underlying metamorphosis. JAEGER's criticism is fully justified, and it is useful as stressing the elusiveness of the ideas in which GOETHE dealt, and the fact that even he himself did not always succeed in grasping them firmly.

The development of GOETHE's theory in his little book is on the whole so limpid in expression that commentary is seldom needed to make it fully intelligible today. The thread, upon which the whole exposition is strung, is the idea of metamorphosis in its two main aspects: *normal* or *progressive;* and *abnormal* or *retrograde.* Normal metamorphosis is the change seen in the successive types of lateral appendage, from the cotyledons, through the foliage leaves, and bracts, to the final reproductive goal in the fruit. In abnormal metamorphosis, on the other hand, there is, in the ascent towards

33. MARTINS, C. F. (1837): *Oeuvres d'histoire naturelle de Goethe, traduits et annotés par* CH. FR. MARTINS *avec un atlas in-folio contenant les planches originales de l'auteur, et enrichi de trois dessins et d'un texte explicatif sur la métamorphose des plantes par* P. J. F. TURPIN. *Paris. Destinée de l'opuscule imprimé,* p. 267. This discourse, which GOETHE called *Schicksal der Druckschrift,* took more than one form, and I have not found the passage cited except in MARTINS' translation.

34. LINNAEUS, C. (1767): *Systema Naturae.* Vol. 2, Editio Duodecima, Reformata. Holmiae; p. 8.

35. JAEGER, G. F. VON (1814): *Ueber die Missbildungen der Gewächse.* Stuttgart; p. 252.

reproduction, a back-sliding to a level which has already been passed, as, for example, when a stamen is developed in petaloid form. It should be noticed that GOETHE uses the term 'leaf' (Blatt) for the member which undergoes successive changes, appearing in the guise of one lateral appendage after another[36]. GOETHE himself recognised that this terminology is unsatisfactory, since the word 'leaf' is inseparably associated in daily usage with the foliage leaf, whereas, on his view, the foliage leaf has no more claim to be itself the typical 'leaf' than has, for instance, the cotyledon or the stamen. A generalised term, such as 'phyllome,' which was given currency in the nineteenth century especially by NAEGELI[37], meets the case better than 'leaf', since it is not hampered by special associations. GOETHE's recognition that neither the foliage leaf, nor any other appendage, is in itself the 'type' leaf, is perhaps the most original feature of his theory. It represents an advance beyond the position adopted by WOLFF, who seems to have regarded the other appendages simply as modifications of the foliage leaf. This difference may be associated with a general difference between the outlooks of the two men; WOLFF was primarily a scientific observer, and GOETHE, primarily an intuitive thinker[38].

GOETHE was not satisfied merely to note the outward signs of metamorphosis; he wanted also to understand its mechanism. The theory at which he arrived was that the changes in the passage from cotyledons to reproductive appendages are due to the gradual elaboration and refinement of the sap as it travels from node to node. At GOETHE's date there were no means of developing such a theory in detail, but the view he tried to express may well be regarded as foreshadowing modern ideas upon the relation of chemistry and form[39]. It has also been suggested that the process of metamorphosis, as visualised by GOETHE, may be restated in twentieth-century terms by interpreting it on genic lines[40].

A notion upon which GOETHE laid much stress in the *Metamorphose* was that the annual plant shows six alternating stages of expansion and contraction. He considered that expansion took place in the passage from the cotyledons to the foliage leaves; the calyx to the corolla; and the sexual organs to the fruit. Contraction, on the other hand, occurred in the passage from the foliage leaves to the calyx; the corolla to the sexual organs; and the fruit to the seed[41]. The artificiality of this scheme is obvious, but GOETHE may have been dimly groping after a conception of periodic rhythm in the development of appendages at the growing apex.

Another hypothesis which GOETHE used in his interpretation of plant life, but which is out of accord with modern views, is that—derived from HEDWIG[42]—of the prime importance of the spiral vessels or tracheids

36. *Metamorphose*, § 119.
37. NAEGELI, C. VON (1884): *Mechanisch-physiologische Theorie der Abstammungslehre.* München und Leipzig.
38. *Cf.* KIRCHHOFF, A., (1867): *l.c.*, pp. 28 and 31.
39. LAKON, G. (1921): *Goethes physiologische Erklärung der Pflanzenmetamorphose als moderne Hypothese von dem Einfluss der Ernährung auf Entwicklung und Gestaltung der Pflanze.* Beihefte zum Bot. Centralbl., Bd. 38, Abt. I, pp. 158-81.
40. HAYATA, B. (1921): *An Interpretation of Goethe's Blatt.* Icon. Plant. Formos. X, pp. 75-95. I know only the referat in Bot. Jahrb., vol. 57, 1922, Literaturbericht, pp. 47-8.
41. *Metamorphose*, § 73.
42. HEDWIG, J. (1781): *l.c.*, p. 308.

(Spiralgefässe)[43]. It is not surprising that almost magical qualities should have been ascribed to these elements in the early days of anatomy, for the crudest technique revealed them distinctly, and it was natural that their spring-like form should suggest peculiar powers. We cannot reproach the earlier writers with their over-emphasis on spiral vessels, when we recall the way in which, even today, the conspicuousness of xylem in stained sections leads botanists at times to treat it as if it were something with an independent identity of its own, merely embedded in the rest of the tissues, like the waterpipes in a building. GOETHE was so much intrigued by the ideas aroused by the spiral tracheids, that, after the *Metamorphose*, he carried his speculations on spiralness in general to a further point in an essay *Ueber die Spiral-Tendenz der Vegetation*[44].

The small amount of controversial matter to be found in the *Metamorphose* includes a disclaimer of the fanciful theory put forward by LINNAEUS under the name of *Prolepsis*[45] or Anticipation. LINNAEUS supposed that vegetative buds consisted of a succession of buds within buds, going on to the sixth generation; no doubt this was an offshoot from the doctrine of preformation[46], which had so widespread an influence in the eighteenth century. He accounted ingeniously for the occurrence of the reproductive phase by postulating that, when a bud produced a flower instead of a vegetative shoot, the six generations enfolded in the bud all came to light at once—future years being as it were, anticipated, and the leaves of successive years being transformed in their due order into bracts, calyx, corolla, stamens, and the pistil with its seeds. LINNAEUS also believed that he had hit upon the mechanism by which the plant achieves this metamorphosis; he supposed that the leafy shoot becomes changed into the flower by the conversion of the cortex into the calyx; the liber into the corolla; the wood into the stamens; and the pith into the pistil with its contents. GOETHE rightly demonstrated the futility of this attempt to relate floral parts to successive zones of tissue[47].

The theory embodied in the *Metamorphose* has had to face much opposition, part of which has been due to careless and often second-hand misinterpretation, but, apart from this, which can easily be remedied, a residue of genuine difficulty is left, due to certain inadequacies in the theory as GOETHE conceived it. The artistic economy of his exposition was achieved at the expense of deliberate and ruthless exclusions, which to some extent reduce the significance of the work. He limited his consideration, for instance, to the annual herb[48], paying very little attention to other life forms, and he specifically omitted monocotyledons in discussing seed-leaves[49].

43. *Metamorphose*, § 60.
44. Sophien-Ausgabe, Abt. II, Bd. 7, pp. 37-68. French translation in MARTINS, C. F. (1837): *l.c.*, pp. 329-33.
45. LINNAEUS, C. (1767): *l.c.*, p. 8; *see also* ULLMARK, H. (1760): *Prolepsis plantarum, in* LINNAEUS, C. (1764): *Amoenitates Academicae*. Lugduni Batavorum. Vol. 6, No. cxviii, pp. 324-41.
46. For GOETHE's attitude to preformation see *Der Inhalt bevorwortet*, p. 120, in *Zur Morphologie*, TROLL ed.
47. *Metamorphose*, § 111.
48. *Metamorphose*, § 6.
49. *Metamorphose*, § 17.

Within the plant itself, his interest scarcely extended beyond the lateral appendages of the stem, and the root he practically ignored. It is true that, in some notes not included in the *Metamorphose,* he spoke of the root as a leaf that absorbs moisture under the earth[50]. He did not, however, follow out this suggestion, and later in life he went so far as to ask how he could be expected to concern himself with such an organ as the root, which shows no ascending progress (Steigerung)[51]. Indeed, as TURPIN[52] pointed out long ago, GOETHE's treatise cannot be said to deal, as he claimed, with the metamorphosis of *plants,* since it is only the metamorphosis of the *appendicular organs* of the stem which comes within its purview. Such limitations of the scope of the work would have been entirely harmless if GOETHE had recognised that the problem, as he set it to himself, and consequently the solution which he proposed, were in their very nature incomplete, and represented, not a full morphological interpretation, but merely a single step towards such an interpretation. He did not, however, see the matter in this light, but he treated his theory, of which he was enamoured, as having the finality of a work of art, rather than the provisional character of a work of science. Though he lived for more than forty years after propounding his thesis, and remained deeply interested in it throughout that time, he was inclined to treat it as something achieved once and for all, rather than as a stepping-stone to further developments. He was prepared to amplify it, and offer additional evidence for it, but he did not feel the urge to leave it behind, as an outgrown phase in a continued progress. It was a defect of GOETHE's amateur pursuit of science that he was too much attached to his personal notions and never attained the professional's hard-earned capacity for seeing his own work in due proportion in the general stream of thought. He himself defended the amateur standpoint, on the ground that the non-professional, being free from the obligation to strive after completeness of knowledge, is better able to reach a height from which he may gain a broad view[53]. He failed, however, to realise that detailed knowledge, not limited to the worker's own special line, though it may seem of little value considered in itself, is yet essential as forming a framework of reference for general principles. He would not have sympathised with the artist who said that the best way to get a broad and generalised effects is, not to ignore the detail, but to paint it in, and afterwards to scrape it out remorselessly with the palette knife.

The confinement of GOETHE's interest to the lateral appendages of the stem was one of the effects of his amateur outlook. This limitation led him to consider the leaf as a primary member. He treated it as 'given', and therefore never attempted to ask the question, "What is the leaf?" This question would have seemed to him to fall outside the sphere of legitimate enquiry. It was characteristic of his approach to problems of thought that he drew a definite distinction between those problems which were suit-

50. Quoted in TROLL, W. (1926): *l.c.,* p. 52.
51. Sophien-Ausgabe. Abt. II, Bd. 6, *Zur Morphologie. Verfolg,* p. 331, *Unbillige Förderung,* 1824.
52. TURPIN, P. J. F. (1837): *Esquisse d'organographie végétale, . . . pour servir à prouver . . . la métamorphose des plantes de Goethe.* Paris et Genève; see p. 7.
53. TROLL ed.: *Der Verfasser teilt die Geschichte seiner botanischen Studien mit.* p. 197.

able for investigation, and others which should be quietly reverenced and left untouched[54]. If he had felt himself justified in trying to understand the nature of the leaf, he might have come to visualise this member, not merely in itself, but also in its relation to the plant as a whole; and he might then have realised that the shoot is a more fundamental unit of plant construction than the leaf, and that the leaf should be explained in terms not of itself but of the shoot. As it was, the leaf was not clearly seen in relation to the shoot until much later, when CASIMIR DE CANDOLLE[55], in the latter half of the nineteenth century, suggested that the leaf might be regarded as *a partial-shoot*. He supposed that the limited growth, and the dorsiventrality, of the leaf as compared with the shoot, might be interpreted as due to the atrophy of the apex and ventral face of the terminal meristematic cone. More recently, as a development of this view, the idea has been propounded that the leaf is *a partial-shoot, which shows an urge towards whole-shoot characters*[56]. It should be understood, however, that this modern version of the partial-shoot theory of the leaf, even if it be an advance on GOETHE's view, makes no claim to be a final morphological interpretation of the plant body. As a further step, an attempt has been made towards a parallel explanation for the root[57]. This attempt is, admittedly, most tentative, and no doubt some generalisation of a more inclusive character will eventually grow out of this sequence of opinions, absorbing and transcending them. Unfortunately, in the long period that has elapsed since DE CANDOLLE's theory was set forth, little notice has been taken of it by botanists, while, on the other hand, GOETHE's treatment of the leaf as an irreducible unit has remained permanently influential; this is partly, perhaps, because the suggestion that anything may be accepted as 'given', and therefore not to be questioned, often receives a ready welcome as a trouble-saving device. Even today, modern German morphology, of the school that sees all hope for the future in a return to GOETHE, takes as a postulate that the leaf is a 'Grundform', in no way derivable from any other member of the plant body[58]. This is indeed scarcely fair to GOETHE, since he himself had moments when —though sometimes in an inverted fashion—he made an approach towards the partial-shoot theory of the leaf. In one of his notes, after saying that "Alles ist Blatt," he suggests that the stem is a leaf that becomes radially symmetrical (Ein Blatt, das sich gleich ausdehnt)[59]. Again, he writes of compound leaves as "in reality branches, the buds of which cannot develop, since the common stalk is too frail"[60].

At the time when GOETHE published the *Metamorphose*, he intended

54. TROLL, W. (1926): *l.c.*, p. 8. *See also* SAUNDERS, [T.] BAILEY (1893): *The Maxims and Reflections of Goethe*. London. No. 577, p. 200.
55. CANDOLLE, C. DE (1868): *Théorie de la Feuille*. Arch. Sci. phys. nat., Genève. Vol. 32, pp. 31-64.
56. ARBER, A. (1941): *The Interpretation of Leaf and Root in the Angiosperms*. Biol. Rev., Cambridge, England, vol. 16, pp. 81-105. This paper includes a fuller account of the partial-shoot theory, and the evidence on which it is based, than can be given here.
57. *See* preceding footnote.
58. TROLL, W. (1938): *Vergleichende Morphologie der höheren Pflanzen*. Berlin, Bd. 1, Teil 2, p. 957.
59. Quoted in TROLL, W. (1926): *l.c.*, p. 52.
60. Sophien-Ausgabe, Abth. II, Bd. 13 (Nachträge zu Bd. 6-12), Nachträge zu Bd. 7. Paralipomena 130, p. 125.

CHRONICA BOTANICA

An International Collection of Studies in the Method and History of Biology and Agriculture

.....**Chronica Botanica.** Vol. 10 (1946), $7.50—Six numbers, about 600 pages

.....**Chronica Botanica.** complete, Vols. 1-10, 1935-1946
Price per volume $7.50 (paper), or $8.75 (buckram)

.....**Chronica Botanica.** Volume.....
All back volumes are still available at $7.50 (paper), or $8.75 (buckram)

.....**Binding case for Chronica Botanica.** Volume ....., $0.75
Binding cases are available for all volumes from vol. 4 onwards

---

Recent and forthcoming issues of Chronica Botanica which are available to non-subscribers. Regular subscribers should not order these unless a second copy is desired

.....Vol. 8, 1, Browne, **A Source Book of Agricultural Chemistry.** $5.00

.....Vol. 8, 2, C. S. Rafinesque, **A Life of Travels.** $2.50

.....Vol. 8, 3, Browne, **Thomas Jefferson and the Scientific Trends of his Time.** $1.25

.....Vol. 9, 1, Jack, **Biological Field Stations of the World.** $2.50

.....Vol. 9, 5/6, Howard, W. L., **Luther Burbank. A Victim of Hero Worship.** $3.75

.....Vol. 10, 1, de Saint-Hilaire, **Voyages au Brésil et Paraguay.** $2.00

.....Vol. 10, 2, Agnes Arber, **Goethe's Botany.** $2.00

.....Vol. 10, 3/4, Merrill, E. D., **Merrilleana — Selected General Writings.** $4.00

.....Vol. 10, 5/6, **Chronica Botanica Calendar** (1946-47), $3.75

.....Vol. 11, 1/2, Whyte et al., **Vernalization and Photoperiodism.** ca. $3.75, *in press*

.....Vol. 11, 3, Rickett, **The R. Botanical Exped. to New Spain.** ca. $2.50, *in press*

.....Vol. 11, 4, Cooper, **Arboretums, their Aims and Scope.** ca. $3.00, *in press*

.....Vol. 11, 5/6, Verdoorn (Ed.), **PALLAS.** ca. $3.75, *in preparation*
A Review of Progress in International Relations and Cooperation in Science

.....Vol. 12, 1, Knight, **Dictionary of Genetics.** ca. $2.50, *in preparation*

.....Vol. 12, 2/3, **Chronica Botanica Calendar** (1948), $3.75, *in preparation*

"ANNALES CRYPTOGAMICI ET PHYTOPATHOLOGICI"

A Collection of Memoirs devoted to general and systematic Cryptogamy and Phytopathology

.....Vol. 1, Garrett, **Root Disease Fungi.** $4.50

.....Vol. 2, Horsfall, **Fungicides.** $5.00

.....Vol. 3, Fullerd, **The Genus Bazzania in C. and S. America.** $5.00

.....Vol. 4, Chester, **The Cereal Rusts.** $5.00

.....Vol. 5, Copeland, **Genera Filicum.** $6.00

.....Vol. 6, Nickerson (Ed.), **Biology of Pathogenic Fungi.** ca. $5.00, *in press*

.....Vol. 7/8, Frear, **Cat. of Insecticides and Fungicides.** 2 vols., ca. $12.00, *in press*

.....**Annales Cryptogamici et Phytopathologici.** Vol. 1 and following
About 2 vols. are being published a year, at prices ranging from about $4.00-$6.00.

.....**Annales Bryologici.** Vols. .....
12 vols. and 4 suppl. vols. have been published and are still available at $4.00.
The serial is now being continued by Annales Cryptogamici et Phytopathologici.

.....Verdoorn, **Manual of Bryology.** $12.00

.....Verdoorn, **Manual of Pteridology.** $14.00

Book Department List 2 — Encircle numbers desired below:—

List 2, **Recent Biological and Agricultural Books, including some older Standard Reference Works:** - 1 - 2 - 3 - 4 - 5 - 6 - 7 - 8 - 9 - 10 - 11 - 12 - 13 - 14 - 15 - 16 - 17 - 18 - 19 - 20 - 21 - 22 - 23 - 24 - 25 - 26 - 27 - 28 - 29 - 30 - 31 - 32 - 33 - 34 - 35 - 36 - 37 - 38 - 39 - 40 - 41 - 42 - 43 - 44 - 45 - 46 - 47 - 48 - 49 - 50 - 51 - 52 - 53 - 54 - 55 - 56 - 57 - 58 - 59 - 60 - 61 - 62 - 63 - 64 - 65 - 66 - 67 - 68 - 69 - 70 - 71 - 72 - 73 - 74 - 75 - 76 - 77 - 78 - 79 - 80 - 81 - 82 - 83 - 84 - 85 - 86 - 87 - 88 - 89 - 90 - 91 - 92 - 93 - 94 - 95 - 96 - 97 - 98 - 99 - 100 - 101 - 102 - 103 - 104 - 105 - 106 - 107 - 108 - 109 - 110 - 111 - 112 - 113 - 114 - 115 - 116 - 117 - 118 - 119 - 120 - 121 - 122 - 123 - 124 - 125 - 126 - 127 - 128 - 129 - 130 - 131 - 132 - 133 - 134 - 135 - 136 - 137 - 138 - 139 - 140 - 141 - 142 - 143 - 144 - 145 - 146 - 147 - 148 - 149 - 150 - 151 - 152

If you might not have the above list and desire a copy of it encircle only "List 2".

Book Order Blank

The CHRONICA BOTANICA CO.

International Plant Science Publishers

Waltham 54, Massachusetts, U. S. A.

P. O. Box 151 — Telephone: Wal. 0600 — Cables: Flora, Waltham, Mass.

☐ **Please send me, with bill:—**

☐ **Please send (remittance enclosed):—**

We pay postage on all orders accompanied by a remittance in full

☐ **Please send through my bookseller**_____

☐ **Please send through your agent in**_____

For a list of our authorized agents see our catalogue or a prospectus

Name_____

Address_____

Please give full mailing address

"A NEW SERIES OF PLANT SCIENCE BOOKS"

Outstanding monographs of various branches of modern plant science

.....vol. 7, Reed, **A Short History of the Plant Sciences.** $5.50

.....vol. 8, Baldwin, **Forest Tree Seed.** $5.00

.....vol. 9, Lloyd, **The Carnivorous Plants.** $6.00

.....vol. 10, Wulff, **Historical Plant Geography.** $5.00

.....vol. 11, Schopler-Noecker, **Plants and Vitamins.** $5.00

.....vol. 12, Erdtman, **An Introduction to Pollen Analysis.** $5.00

.....vol. 13, Bawden, **Plant Viruses and Virus Diseases.** $5.00
Second, entirely revised edition

.....vol. 14, Hoagland, **Lectures on the Inorganic Nutrition of Plants.** $4.00
(Prather Lectures at Harvard University)

.....vol. 15, Wodehouse, **Hayfever Plants.** $5.00

.....vol. 16, Verdoorn (Ed.), **Plants and Plant Science in Latin America.** $6.00
("Invaluable"—Henry A. Wallace)

.....vol. 17, ZoBell, **Marine Microbiology.** $5.00

.....vol. 18, Wilde, **Forest Soils and Forest Growth.** $5.00

.....vol. 19, Johansen, **Plant Embryology.** ca $6.00, *in press*

.....vol. 20, Dachnowski-Stokes, **Peat Resources of the World.** ca. $4.75, *in press*

.....vol. 21, Kelley, **Mycotrophy in Plants.** ca. $4.75, *in press*

.....vol. 22, Condit, **The Fig.** ca. $5.00, *in press*

.....vol. 23, Howes, **Vegetable Gums and Resins.** ca. $4.75, *in press*

.....**"A New Series of Plant Science Books."** Vol. ..... and following
About 5 vols. are being published a year, at prices ranging from about $4.00-$6.00

* * * * *

.....Honig *and* Verdoorn, **Science and Scientists in the Netherlands Indies.** $4.00

* * * * *

Catalogues and detailed prospectuses available upon request!

Over!

eventually to produce, as a sequel, a more comprehensive account of the subject, fully illustrated. His commitments—literary, scientific, and administrative—increased, however, so rapidly, that the scheme was never fulfilled. It is at least arguable that this failure is not to be regretted. In its own small-scale *genre*, the *Metamorphose* is a finished work, and it is doubtful if any attempt to expand it, without a definite strengthening of the thread of theory that runs through it, would have been happy in its result; the book in its 1790 form was, in GEOFFROY SAINT-HILAIRE's phrase, "immédiatement complète"[61]. Though the larger work projected was never written, GOETHE continued all his life to amass material bearing on his theory of plant morphology. As well as the writings printed in his lifetime, all his extant notes on the subject have been retrieved and published with pious care[62], including even the scribbles with the aid of which he jotted down his ideas on plant form; an example of these "characteristischen Federstrichen" is reproduced on p. 118. Fragmentary as his notes are, they are still rich in suggestion for thinkers of the present day. Judging him by the *Metamorphose* alone, modern botanists have been liable to underestimate GOETHE's actual botanical knowledge. We have now learned, however, that he was not only active as a collector, but that the pictures which he got together with a view to illustrating his definitive work, bear witness to acute observation and a keen, if selective, insight. These drawings were made under his direction, and, in part, with his own hand. He had a number of them engraved, so that they would be ready when he required them; but one of the hindrances to the production of his intended book was that, when the copper-plates were wanted, they had been mislaid, and they do not seem to have been found during his lifetime[63]. In the present century many of GOETHE's figures have been brought to light and printed. One set of pictures is from a small portfolio dating from 1795[64], preserved in the GOETHE-Nationalmuseum at Weimar; it was published by HANSEN in 1907[65]. Another set, including drawings from a large portfolio of 1830 in the Weimar Bibliothek, has been exquisitely reproduced by SCHUSTER[66], with a full critical commentary, and some reconsideration of HANSEN's material. This corpus of botanical drawings, in which teratology is strongly represented, and which also includes beautiful studies of seedlings, shows that GOETHE was fully alive to those aspects of factual detail which bore upon subjects which interested him. One illustration, which is of special significance in connexion with GOETHE's morphology, shows the various forms of compound leaf met with in *Aegopodium podagraria* L. (goutweed)[67]. These coloured drawings were made by a professional artist on the basis of pencilled outlines, which SCHUSTER believes were GOETHE's own. GOETHE's attention is known to

61. GEOFFROY SAINT-HILAIRE (ÉTIENNE) (1831): *Sur des Écrits de Goethe lui donnant des droits au titre de savant naturaliste*. Ann. d. Sci. nat., T. 22, pp. 188-93; *see* p. 190.
62. *See* especially the Sophien-Ausgabe, and TROLL ed.
63. TROLL ed. *Nacharbeiten und Sammlungen*, p. 239.
64. SCHUSTER, J. (1924): *Goethe, die Metamorphose der Pflanzen mit dem Originalbildwerk*. Berlin. Pp. 116, 118, 121.
65. HANSEN, A. (1907): *l.c.*
66. SCHUSTER, J. (1924): *l.c.*
67. SCHUSTER, J. (1924): *l.c.*, pl. VII.

have been specially attracted by the foliage of this plant, for one of his notes[68] mentions its "remarkable *folia composita*", of which "the single leaflets are in part composite again, in part more or less indented, or completely simple"; and GOETHE records his intention of making a collection of them. His strong and wide-ranging artistic gift, shown, for instance, in the drawings on pp. 65, 116 and plate 25, was invaluable to him as a botanist. His preliminary sketch of an opening horse chestnut bud with its "calyx" of bracts is reproduced on p. 116. Another picture, which is of peculiar interest to students of GOETHE's botany, is that of a proliferating pink[69]. This delicate pencil outline is apparently by GOETHE himself, for in the summer of 1787 he found such a specimen in Italy, and mentioned that, since he had no means of preserving this marvellous form (Wundergestalt), he attempted an exact portrayal of it[70]. It was evidently a labour of love, for he wrote of the plant in question as embodying all his ideas, and giving him rapturous delight[71].

This rapturous delight seems to have been aroused in GOETHE's mind primarily by any fulfilment of his desire to resolve the antithesis between the Many and the One—a desire which is the keynote to the whole of his biological work. In this connexion the prose poem, *Die Natur,* reprinted here with a translation (pp. 121-124), has special significance. Whatever answer may ultimately be found to the riddle of its authorship[72], we know from GOETHE's own statement[73], made nearly half a century after the *'Fragment'*, as it was originally called, appeared, that, in looking back over his scientific career, he regarded *Die Natur* as representing the views which he had held in the earlier part of the decade preceding the publication of the *Metamorphose,* and which he considered that he had since outgrown. Throughout the poem runs the thread of an intense awareness of the antithetic and paradoxical attributes characterising those aspects of the universe which the writer personifies as *Die Natur*. GOETHE may well have been for a time overmastered by the consciousness of such contradictions, but his mental bias would not let him rest permanently at this stage; he soon began to seek, and to believe that he had found, a reconcilement of the antithetic elements in existence. His solution was not, however, truly synthetic, since it led him to stress the One, and to absorb the Many into it. It is possible to hold that his devotion to the idea of the One led to a certain sacrifice of his intellectual integrity. Hankering, as he did, to regard Nature as unified and directional, rather than inconstant and capricious, he came to see her apparent inconsistencies merely as masks for essential oneness. It was from this viewpoint that his morphological work was developed. According to the theory of plant members, which he put forward in the *Metamorphose,* he visualised the indescribably various appendicular organs of plants all as expressions of one form—the leaf. In his wider study of morphology he went further in the same direction, and he reached the concept of a single

68. Sophien-Ausgabe, Abth. II, Bd. 13 (Nachträge zu Bd. 6-12), Nachträge zu Bd. 7. Paralipomena 137, p. 132.
69. SCHUSTER, J. (1924): *l.c.*, Fig. 2, p. 79.
70. Sophien-Ausgabe, Bd. 32. *Italiänische Reise. III. Zweiter Römische Aufenthalt. Störende Naturbetrachtungen.* P. 47 (July 1787).
71. Sophien-Ausgabe, Bd. 32, *Lesarten* (June and July 1787), p. 389.
72. On this question *see* pp. 119-120.
73. Letter to Kanzler F. T. A. H. VON MUELLER, May 24, 1828, TROLL ed., p. 447.

type in accordance with which everything was fashioned (den Begriff des Typus, nach dem sich alles bildet)[74]. Though he made this idea peculiarly his own, he did not originate it. It is a device for figuring out the problems of existence to which those who see these problems on broad lines have frequently resorted[75]. In the *Metamorphose* the type concept is implicit rather than explicit; the word *Urblatt*, for the type leaf, does not occur[76]. In his other notes and writings the idea of the type is more fully developed, but the meaning which he attached to its defies exact definition; he thought of it as a Proteus that eludes any one form of expression and can only be glimpsed in a piecemeal and paradoxical fashion[77]. Moreover, in trying to convey his views in another tongue, we are faced with the difficulty that in English we have nothing really equivalent to those words with an *Ur* prefix which GOETHE employed in this connexion (*Urbild, Urtier, Urpflanze*, etc.). Fortunately the significance of the type concept is revealed in the examples which he cites, rather than in any verbal formulation. He suggests, for instance, that the *Orchidaceae* might be described as monstrous *Liliaceae*[78]; that is to say, he thought of them as a teratological deviation from the *Liliaceae* type. He would, indeed, have been pleased with a recent account of an abnormal flower of *Cypripedium*, which was trimerous and perfectly regular[79]. It would be an error to suppose, on the ground of his ideas upon the relation of flower structure in the *Orchidaceae* and *Liliaceae*, that GOETHE thought of the "type" as an ancestral form, which had had actual existence at some previous period, for he was not an evolutionist in the modern sense[80]. On his view the "Urpflanze" could neither be described adequately in words, nor represented pictorially—an essential limitation which some of his followers unfortunately ignored. His type concept has frequently been equated with the *forms* or *ideas* of PLATO[81], and some of GOETHE's expressions may be interpreted as indicating that he so regarded it, but it[82] is doubtful if this identification can be accepted. HANSEN[83] is probably right in his opinion that GOETHE's "Blatt" is, on the contrary, a conjectural concept, enabling a hypothetical situation to be visualised. On this reading it is recognised as comparable with such terms as atom and molecule, and as thus being merely a tool of thought. From this standpoint, which has much to favour it — though GOETHE himself would by no means have accepted it — the type concept is seen as having merely provisional status, so that we are justified in discarding it when it has served its turn in leading us to something more

74. Note appended to a letter to NEES VON ESENBECK, April 2, 1828. *Goethes Briefe*. Sophien-Ausgabe, Bd. 44, p. 54.

75. *See* especially an interesting study of J. B. ROBINET and the type concept in LOVEJOY, A. O. (1936): *The Great Chain of Being*. Harvard University Press; pp. 269-83.

76. On this point *see* HANSEN, A. (1919): *Goethes Morphologie*. Giessen; p. 26.

77. *Vorarbeiten zu einer Physiologie der Pflanzen. Einleitung*. Sophien-Ausgabe, Abth. II, Bd. 6, Theil I, p. 312-3.

78. *Nacharbeiten und Sammlungen*. TROLL ed., p. 251.

79. CURTIS, J. T. (1941): *Peloric Flowers in Cypripedium reginae Walt.* Amer. Midland Nat., vol. 25, pp. 580-3.

80. It seems scarcely possible to accept SHERRINGTON's suggestion that GOETHE's views were akin to those of LAMARCK; *l.c.*, p. 20.

81. *See*, for example, SHERRINGTON, C. (1942): *l.c.*, p. 22.

82. GOETHE speaks, for instance, of the type animal (Urtier) as "den Begriff, die Idee des Tieres"; see *Der Inhalt bevorwortet*, in *Zur Morphologie*, TROLL ed., p. 122.

83. HANSEN, A. (1907) *l.c.*, p. 91.

adequate. For instance, if we adopt the partial-shoot hypothesis of the leaf —as representing an advance upon GOETHE's thought—we need no longer postulate a type-phyllome from which all the lateral appendages of the stem have been derived; for on this view they are not derived *from one another,* but are related merely in so far as they are all incomplete shoots. They are therefore parallel but independent members, rather than divergences from a single primaeval leaf form. GOETHE in 1784 spoke of "paralleling" organic parts which are alike in their inner nature, but wholly unlike in appearance[84], but he did not develop this suggestion, nor did he realise that the notion of parallelism might eventually replace his naiver type concept[85].

In GOETHE's eyes the type principle was the clue to the interpretation of animals as well as plants. It was through this principle that in zoology he reached an important factual discovery—which was not, however, as completely new as he believed it to be[86] — that of the intermaxillary bone in man[87]. None of GOETHE's thinking was ever isolated from his whole mental activity, and the type concept, or, more widely, the idea of *Ur* phenomena, was to him a clue to be followed not in science merely; it was, rather, one of the keys which gave him the freedom of the universe as a whole. He applied this concept to man (*Urmensch*), and even to the landscape which forms his background (*Urlandschaft*). This development of the type concept lies outside our present scope; for a stimulating study of it, the reader may be referred to HUMPHRY TREVELYAN's work[88].

It was not until late in GOETHE's life that he came into contact with A. P. DE CANDOLLE's cognate ideas. In 1828, F. J. SORET, a Swiss friend, introduced him to DE CANDOLLE's *Organographie végétale,* which had been published in the previous year. GOETHE was greatly impressed by the doctrine of symmetry there developed, a doctrine which bore some affinity to his own views. He planned a work[89] to include a French version of the *Metamorphose,* and also the chapter in DE CANDOLLE's *Organographie,* "Sur la symétrie des plantes", and other representative extracts from this book, and from DE CANDOLLE's *Théorie élémentaire* (1813), accompanied by German translations. The work as eventually published was much reduced, and the projected DE CANDOLLE section was omitted, but the fact that GOETHE had intended to introduce it, shows that he felt no jealous rivalry; on the contrary, he expressed his wonder at the power shown by the Master—as he calls DE CANDOLLE—in handling an infinity of detail[90]. DE CANDOLLE's views had been reached independently, for it is recorded by his son[91] that his

84. *Versuch aus der vergleichenden Knochenlehre.* (1784). TROLL ed., p. 380.

85. On the replacement of the *type* concept by that of *parallelism, cf.* ARBER, A. (1937): *The Interpretation of the Flower: a study of some aspects of morphological thought.* Biol. Rev. (Cambridge, England), vol. 12, pp. 157-84; *see* pp. 173 etc.

86. SHERRINGTON, C. (1942): *l.c.*, pp. 21-2.

87. *Versuch aus der vergleichenden Knochenlehre, dass der Zwischenknochen der obern Kinnlade dem Menschen mit den übrigen Tieren gemein sei.* (1784). TROLL ed. p. 363 *et seq.*

88. TREVELYAN, H. (1941): *Goethe and the Greeks.* Cambridge, England. *See* Chap. IV, especially pp. 159-78.

89. UHDE, H. (1877): *Goethe Briefe an Soret.* Stuttgart. Letter to SORET dated August 3, 1828, pp. 56, 57. Also Sophien-Ausgabe, Abt. II, Bd. 13 (Nachträge zu Bd. 6-12), Nachträge zu Bd. 6, paralipomena 70, p. 63.

90. UHDE, H. (1877): *l.c.* Letters to SORET, July 14, 1828, p. 51, and June 28, 1828, p. 43.

91. CANDOLLE, A. P. DE (1862): *Mémoires et Souvenirs.* Genève et Paris; p. 573.

father did not read German, and that he knew nothing of the *Metamorphose* until 1823—more than thirty years after its publication—when a friend sent him an epitome of it in French; he was thus not fully acquainted with it even when he produced the *Organographie* in 1827. GOETHE showed no bitterness at this disregard of his work, which was, indeed, eventually more than compensated by the part which DE CANDOLLE's pupils played in disseminating the ideas developed in the *Metamorphose*[92]. One is tempted to think that there would have been more effective contact between GOETHE and DE CANDOLLE if they had been born two centuries earlier, when Latin was the *lingua franca* of scientific men.

DE CANDOLLE's morphology centred in the notion of the basic symmetry of all plant forms — "la symétrie normale ou primitive des êtres"[93]. The asymmetry that, in fact, frequently occurs, he regarded as secondary, and as requiring in each case some special explanation. We cannot here trace the history of the symmetry conception; it was not new when DE CANDOLLE propounded it, but he was the first to give it full expression. DE CANDOLLE's law of symmetry, and GOETHE's principle of metamorphosis, were in no way incompatible. They were concerned with the same phenomena, though seen from somewhat different standpoints; each contained something of the truth, though neither was the whole truth. Like GOETHE, DE CANDOLLE was not far from taking the step which would have set him on the way to the conception of the leaf as a partial shoot; his doctrine would indeed have fitted exactly with the notion of the leaf as a shoot which — owing to its relation to the parent shoot — has lost its radial symmetry and retained dorsiventral symmetry alone. But for his close adherence to root, stem, and leaf, as rigidly discrete units (organes fondamentaux)[94], which cannot be interpreted in terms of one another, he might have seen how to relate the leaf to the shoot, instead of leaving this feat to be accomplished by his grandson, CASIMIR, many years later.

So far as we know, DE CANDOLLE never concerned himself about the differences between his own mentality and that of GOETHE. GOETHE, however, with his intense interest in psychological problems, discusses these differences, and their results, in a way which throws light upon his own general attitude to scientific work. In a letter to SORET of April 2, 1828[95], GOETHE treats DE CANDOLLE's work and his own as exemplifying the contrast between analysis and synthesis. He held these two modes of approach to be reciprocal, mutually helpful even in their antagonisms, and equally indispensable both in theory and in practice. Though he knew that analysis was essential, and respected and admired it in DE CANDOLLE, it was synthesis to which the whole of his mental and psychical equipment inclined him personally. How deep-seated his feeling for synthesis was, is indicated by his prophecy that poetry and science, which in his day dwelt in total isolation, would eventually come to a happy meeting on a higher plane.[96]

92. *See* p. 86.
93. CANDOLLE, A. P. DE (1827): *Organographie végétale*, Paris, vol. 2, p. 240.
94. CANDOLLE, A. P. DE (1827): *l.c.*, vol. 1, pp. 139-40.
95. *See* SCHUSTER, J. (1924): *l.c.*, pp. 107-8.
96. *Schicksal der Druckschrift.* TROLL ed., p. 215.

In the fragmentary *Zur Morphologie,* published in 1817, GOETHE emphasizes the disadvantages to biology of the analytical approach through chemistry and anatomy. He says that, by this method, the living creature is dissected into its elements, but that from these elements it is impossible to reconstitute and reanimate it[97]. Those today who advocate a holistic or organismal view of life, have often used expressions almost identical with this of GOETHE's, but without realising that he had been there before them.

GOETHE's synthetic views share the difficulty which besets holistic interpretations in general — that they tend to carry the enquirer out of the sphere of science, which, in the stricter sense, is a discipline obtaining its results by the application of methods of a manageable kind. SCHILLER, in a letter to GOETHE written in 1794[98], points out that to embark on the heroic path of taking all Nature together, and seeking in the totality of phenomena for the explanation of the individual, is to reach after a goal which there is no hope of attaining in a lifetime. GOETHE's own solution of this difficulty did not lie in the attempt to apply scientific method where he felt it to be out of place, but in the development of symbolic thought. Faced with the manifoldness of phenomena, he tried to reconcile it with his basic idea of the unity of all things, by striving to discern the Whole in the tiniest individual thing[99]. Any subject, however small and limited, with which he concerned himself, became for him the microcosm of something universal; it is not surprising that he was conscious of a special appeal in the Old Testament story of SAUL, the son of KISH, who went forth to seek his father's asses, and found a kingdom[100].

Symbolic interpretations of experience came to be more and more important to GOETHE, especially in the latter part of his life[101]. Such interpretations involve a special stress upon *comparison,* and GOETHE's great service to morphology lay in the recognition that its basis must be essentially comparative. This comparative way of viewing nature contrasts with the method that is 'scientific' in the rigid sense, and consists in the attempt to treat biological phenomena on mechanical lines. The latter method had little attraction for GOETHE; he wrote that "The application of mechanical principles to organic Nature has only made us the more aware of the wholeness of the living being"[102]. In order to appreciate GOETHE's attitude, it is necessary to consider how his ideas were related to 'explanation', as this is generally understood in science. The word 'explanation' may be held to correspond to the German word 'Erklärung', TROLL's definition[103] of which includes setting forth the cause of a phenomenon, or finding the orderly place for a special fact in a causal sequence. This idea of explanation — as equivalent to the locating of the thing-to-be-explained in a chain of causation — was alien to GOETHE's mind; he held the view that "The thinker

97. *Die Absicht eingeleitet,* in *Zur Morphologie.* TROLL ed., pp. 114-5.
98. *Briefwechsel zwischen Schiller und Goethe.* Theil I, 1794 und 1795. Stuttgart und Tübingen, 1828, pp. 13-4.
99. "das Ganze im kleinsten erblicken". Quoted in TROLL, W. (1926): *l.c.,* p. 36.
100. *Wilhelm Meister's Lehrjahre.* Sophien-Ausgabe, Bd. 23, pp. 309-10.
101. TROLL, W. (1926): *l.c.,* p. 97 *et seq.*
102. *Betrachtung über Morphologie überhaupt.* TROLL ed., p. 229.
103. TROLL, W. (1925): *Gestalt und Gesetz.* Flora, N. F. Bd. 18 and 19 (G. R. Bd. 118 and 119), GOEBEL Festschrift, pp. 536-65; *see* p. 556.

makes a great mistake when he asks after cause and effect; they both together make up the indivisible phenomenon"[104]. He recognised, however, that to range appearances under the various forms of causation was an activity arising inevitably from the construction of the human mind, and he was prepared to regard this as justifiable, even when it fell outside his own scheme of things. For instance, in discussing VAUCHER's work, GOETHE speaks of this author's explanations of physiological phenomena in terms of purpose, as being foreign to his own outlook, but adds that he quarrels with no one who chooses to adopt the standpoint of teleology[105].

For the type of explanation based on cause and effect, GOETHE substituted a process that can be described only by the untranslatable German word, 'Darstellung', which may be defined, approximately, as the demonstration or representation of an object, brought into relation with others in such a way that its significance is revealed[106]. GOETHE himself spoke of morphology as a discipline which "nur darstellen und nicht erklären will"[107].

We know that GOETHE's actual visual impressions were peculiarly intense, and greatly influenced his mode of thought; indeed, his inclination always drew him to 'picture thinking'. For this way of apprehending nature, TROLL[108] uses the expression "intuitive Anschauung", which might be called, "thinking with the mind's eye"; it lies midway between sensuous perceptions reached through bodily sight, and the abstract conceptions of the intellect. Actually to "see", as it were, the solution of a problem, is, to most biologists, an experience as rare as it is delightful; but GOETHE's mind worked in this way all the time. He even made a vigorous and prolonged attempt to apply the 'Anschauung' method to physics, an attempt which was obviously foredoomed to failure. He tried to tackle the problems offered by colour[109], on the assumption that such physical questions could be studied non-mathematically. Even here, however, it is possible to hold that his attitude — fantastic as it may appear when judged from the standpoint of modern physics — was not entirely devoid of value. There is a modicum of truth underlying the picturesque exaggeration of CROCE's statement that GOETHE, "emerging from a century intoxicated with mathematics, understood and had the courage to assert that mathematics do not lead to the knowledge of reality, and that in them there is nothing exact but their own exactness"[110].

GOETHE was not at home in thought which was purely abstract; he says of himself that for philosophy in the strict sense he had no capacity (kein

104. SAUNDERS, [T.] BAILEY (1893): *l.c.*, No. 394, p. 146.

105. *Wirkung meiner Schrift.* TROLL ed., p. 259; for GOETHE's views on teleology, *see* ECKERMANN, J. P. (1836): *Gespräche mit Goethe in den letzten Jahren seines Lebens. 1823-1832.* Theil II. Leipzig; p. 282; and *Conversations of Goethe with Eckermann and Soret* (1850): Translated by J. OXENFORD. London; vol. 2, p. 347.

106. TROLL, W. (1925): *l.c.*

107. *Betrachtung über Morphologie überhaupt.* TROLL ed., p. 228.

108. On this subject *see* TROLL, W. (1926): *l.c.*, p. 78, etc., and HANSEN, A. (1907): *l.c.*, pp. 277-8.

109. For an interesting and clear account of GOETHE's *Farbenlehre, see* SHERRINGTON, C. (1942): *l.c.*, pp. 8-18.

110. CROCE, B. (1923): *Goethe.* Translated by E. ANDERSON, with an introduction by D. AINSLIE. London; p. 14.

Organ)[111]. SCHILLER[112], with his keener power of thought on the philosophic plane, criticised GOETHE as apprehending all too much through the senses. Despite such drawbacks, GOETHE's mode of approach had, and still has, a special and original quality; for in including and emphasizing visual perception, and relating it to thought on the non-tangible plane, it points the way towards a reconcilement of the purely abstract with the purely sensuous. Early in this Introduction, we spoke of the vexed question of GOETHE's scientific status. After a consideration of his biological thought, this question still remains fraught with difficulty, for the catholicity of his mind, and the kaleidoscopic character of his activity, defy neat labelling. As a botanist, he began with a simple utilitarian interest in plants; he passed through a brief period in which he studied the multiplicity of the plant world from the standpoint of the descriptive naturalist; this was succeeded by a phase in which his mind was entirely possessed by comparative morphology, a subject to which the value of his contribution, and the inspiration which later workers have derived from it, are undeniable; and, finally, by a transition natural to his mental growth, he reached a stage in which his morphological thought reached out to the reconciliation of the antithesis between the senses and the intellect, an antithesis with which traditional science does not attempt to cope. It has been suggested by a literary critic that GOETHE was "a great poet who *grew out* of poetry"[113]. Approaching him, as we have done here, through the medium of his plant studies, we may perhaps offer the comparable conclusion, that GOETHE was a great biologist, who, in the long run, overstepped the bounds of science.

A Note on Translations: — Two French translations of the *Versuch die Metamorphose der Pflanzen zu erklären* (1790) were published in GOETHE's lifetime, both by Swiss botanists who had been pupils of DE CANDOLLE. The earlier, by F. GINGINS-LASSARAZ, appeared in 1829[114]; in GOETHE's own copy of this work there are manuscript notes pointing to its infidelity and incompleteness[115]. The second translation, by F. J. SORET, came out two years later: *Essai sur la Métamorphose des Plantes . . . suivi de notes historiques,* Stuttgart, 1831[116]. SORET, who criticised GINGINS-LASSARAZ as having used nineteenth-century technical terms, which were an anachronism[116a], described his own version as "travaillée avec soin sous les yeux mêmes de l'auteur". GOETHE was enthusiastic about this translation, which he spoke of, while it was in progress, as being "more and more felicitous"[117]; but it is too free to be as helpful as might have been expected in the interpretation of obscure points. It seems probable that GOETHE, in his old age, did not, in reality, criticise it intensively, and also that he gave SORET con-

111. *Einwirkung der neueren Philosophie.* TROLL ed., p. 285.
112. *Schillers Briefwechsel mit Koerner* (1847): Teil II. Berlin. Letter of Nov. 1, 1790, p. 207.
113. *The Centenary of Goethe.* Times Literary Supplement. London. March 24, 1932, p. 210.
114. *Essai sur la Métamorphose des Plantes, Traduit de l'Allemand sur l'Édition originale de Gotha* (1790) par M. FRÉDÉRIC DE GINGINS-LASSARAZ. Genève, 1829.
115. SCHUSTER, J. (1924): *l.c.*, p. 110, footnote 3.
116. For the German title *see* citation in footnote 1, p. 67.
116a. UHDE, H. (1877): *l.c.*, p. 93.
117. *Conversations of Goethe with Eckermann and Soret* (1850): *l.c.*, vol. 2, p. 374; ECKERMANN, J. P. (1836): *l.c.*, p. 317.

siderable latitude, because he held that the differences between French and German mentality made it necessary for his ideas to be presented in a somewhat different guise when they were intended for a French audience. He feared that a nation, which demands in everything entire clarity of expression and thought, might suspect him of falling into mystic reveries if he wrote for them in the style which it was natural for him to use in addressing his compatriots[118].

Five years after GOETHE's death, another French translation appeared from C. F. MARTINS[119].

It was not until 1863 that a version was published in English: *Essay on the Metamorphosis of Plants,* Translated by EMILY M. Cox; with Explanatory Notes by MAXWELL T. MASTERS (*Journal of Botany,* vol. 1, pp. 327-45, 360-74, 1 pl.). My own translation, which follows this Note, was made independently, but, when it was completed, I compared it throughout with the *Journal of Botany* version, and, wherever the latter seemed to me to convey the sense more accurately than my own, I modified mine in accordance with it.

Another English translation appeared in the *Notes and Correspondence of the Anthrosophical Agricultural Foundation,* vol. 4, No. 8, April 1937. I am indebted to Mr. W. T. STEARN for showing me this version in the year of its publication, but I have not been able to consult it during the preparation of my own rendering. It is described as based on the *Journal of Botany* translation, and on another by Mrs. MIRBT; it has an introduction by G. KAUFMANN.

Those who are curious in such matters may find amusement in certain specimens of poetical versions which appeared in the *Gardener's Chronicle,* vol. 4, 1844, pp. 117 and 133.

In translating the title of GOETHE's book, I have used the word "Attempt", instead of "Essay", for "Versuch", because I believe that "Attempt" more nearly expresses GOETHE's intention. BATSCH's introduction to botany, which was published three years before GOETHE's work, and which he cites, may have suggested the form of the title, for it is called *Versuch einer Anleitung zur Kenntniss und Geschichte der Pflanzen.* BATSCH's work is a solid and detailed textbook; it cannot be called an "Essay", if the word is used in the sense which has in general been attached to it from the days of MONTAIGNE onwards. It seems safe to assume that GOETHE, in his first edition, followed BATSCH in employing the term "Versuch" in the modest sense of "something attempted" — a sense which the English word "essay" conveyed in former days, but which it has now lost. In SORET's French and German issue of 1831, the title losing something of its humility, is changed to *Versuch über die Metamorphose der Pflanzen;* here the word "Essay" seems to be the best equivalent for "Versuch", and "Essai" is used in the French translation.

In the following version, those footnotes, or parts of footnotes, which are not in the original text, are initialled (A.A.). Readers who wish for fuller annotation will find it in TROLL ed., p. 455 *et seq.*

118. *See* SORET's translation, p. 225.
119. Title cited on p. 74.

J. W. von Goethe

Herzoglich Sachſen-Weimariſchen Geheimenraths

Verſuch die Metamorphoſe der Pflanzen zu erklären.

Gotha,
bey Carl Wilhelm Ettinger.
1790.

TRANSLATION

An ATTEMPT *to* INTERPRET *the* METAMORPHOSIS *of* PLANTS

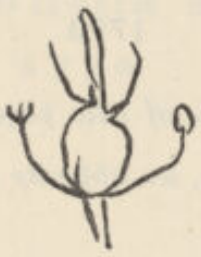
by

J. W. von GOETHE

1790

[*For facsimile of title page of original edition, see opposite page*]

CONTENTS



I am indeed not unaware that this path is obscured by clouds, which will pass over from time to time. Yet these clouds will easily be dispersed when it is possible to make the fullest use of the light of experience. For Nature always resembles herself, although she often seems to us, on account of the inevitable deficiency of our observations, to disagree with herself. (LINNAEUS, Anticipation in Plants, Diss. I[120]).

INTRODUCTION

§ 1

Anyone who pays a little attention to the growth of plants will readily observe that certain of their external members are sometimes transformed, so that they assume — either wholly or in some lesser degree — the form of the members nearest in the series.

§ 2

Thus, for example, the usual process by which a single flower becomes double, is that, instead of filaments and anthers, petals are developed; these either show a complete resemblance in form and colour to the other leaves of the corolla, or they still carry some visible traces of their origin.

§ 3

If we note that it is in this way possible for the plant to take a step backwards and thus to reverse the order of growth, we shall obtain so much the more insight into Nature's regular procedure; and we shall make the acquaintance of the laws of transmutation, according to which she produces one part from another, and sets before us the most varied forms through modification of a single organ.

§ 4

The underlying kinship of the various external members of the plant, such as the leaves, calyx, corolla, and stamens, which develop after one another, and, as it were, from one another, has long been recognised by naturalists in a general way; it has indeed received special attention, and the process, by which one and the same organ presents itself to our eyes under protean forms, has been called the *Metamorphosis of Plants.*

§ 5

This metamorphosis displays itself in three modes: *normal, abnormal,* and *fortuitous.*

§ 6

Normal metamorphosis may also be called *progressive*: for it is that which may be perceived always working step by step from the first seed-leaves to the final development of the fruit. Through the change of one form into another, it passes by an ascent — ladder-like in the mind's eye —

120. This is the translation of the citation as given by GOETHE; the full reference is ULLMARK, H. (1764): *Prolepsis plantarum. In* LINNAEUS, C., *Amoenitates Academicae,* Lugduni Batavorum. Vol. 6, No. cxviii, p. 341. (A.A.).

to that goal of Nature, sexual reproduction. It is this progression which I have studied attentively for a number of years, and which I shall attempt to elucidate in the present essay. This being our standpoint, we will consider the plant, in the following demonstration, only in so far as it is an annual, and passes by continuous progression from the seed up to the fructification.

§ 7

We may give the name of *retrograde* metamorphosis to that which is *abnormal.* As in the normal course, Nature hastens forward to her great end, so in the abnormal, she takes one or more steps backwards. As she there, with irresistible impulse and the full exertion of her might, fashions the flowers and prepares them for the works of love; so here she slackens, as it were, and leaves her creation before it reaches its goal, in an undetermined and powerless condition. Though in this state it is often agreeable to our eyes, in its true inwardness it is feeble and ineffectual. From our acquaintance with this abnormal metamorphosis, we are enabled to unveil the secrets that normal metamorphosis conceals from us, and to see distinctly what, from the regular course of development, we can only infer. And it is by this procedure that we hope to achieve most surely the end which we have in view.

§ 8

We will, on the other hand, avert our eyes from the third kind of metamorphosis, which comes about *contingently,* as a result of external causes, especially through the action of insects; for this phenomenon might frustrate our purpose by diverting us from the direct path which we ought to follow. Perhaps there will be an opportunity to speak elsewhere of these excrescences, which, though monstrous, are still subject to definite limitations.

§ 9

I have ventured to draw up the present work without giving illustrative plates, which however in many respects might seem necessary. I propose to reserve them for the sequel, which can be done the more easily, since enough material is left over for the elucidation and further development of the present short and merely preliminary essay. It will not then be necessary to produce so formal a treatise as this one. I shall have the opportunity of bringing forward much cognate matter; and passages extracted from authors of a like way of thinking will then find their natural place. Especially I will not fail to make use of any suggestions from the experts who today are the glory of this noble science. It is to them that I commit and dedicate these pages.

I. CONCERNING THE SEED-LEAVES

§ 10

Since we have undertaken to observe the sequence of stages of plant growth, let us turn our attention forthwith to the plant at the moment when it germinates. At this stage we may easily and exactly recognise the parts which directly belong to it. It leaves its husks more or less completely in the earth; these we will not now investigate. In many cases, when the root

has anchored itself in the soil, the plant brings forth into the light the first organs of its upper growth, which were already present, hidden within the seed-coat.

§ 11

These first organs are known under the name of *Cotyledons*. They have also been called seed-valves, kernel-pieces, seed-lobes, and seed-leaves; these names are an attempt to denote the various forms which the cotyledons assume.

§ 12

They often appear shapeless, crammed, as it were, with crude matter, and as much extended in thickness as in breadth[121]; their vessels are unrecognisable, and scarcely to be distinguished from the mass as a whole. These cotyledons bear scarcely any resemblance to a leaf, and we may be misled into taking them for organs belonging to some special category.

§ 13

Nevertheless in many plants they approach leaf form; they increase in area and become thinner; when exposed to light and air they assume a deeper green; the vessels which they contain become more recognisable, and more similar to the veins of a leaf.

§ 14

Finally they appear before us as true leaves, the vessels of which are capable of the finest development. Their resemblance to the succeeding leaves prevents our taking them for special organs; we recognise them, rather, as the first leaves of the stem.

§ 15

But since we cannot think of a leaf without a node, or of a node without a bud, we may be allowed to conclude that the point where the cotyledons are attached is the veritable first nodal point of the plant. Confirmation of this view is afforded by those plants which put forth young buds immediately at the base of the cotyledonary wings, and produce complete shoots from the first nodes, as the horse-bean (*Vicia Faba* L.) is wont to do.

§ 16

The cotyledons are generally twinned, and this leads us to make an observation, the significance of which will be more fully appreciated at a later point. This is that the leaves of this first node are often *paired* when the succeeding leaves of the stem stand *alternately;* there is here an approach and association of parts which Nature, later in the sequence, disjoins and separates from one another. This is still more noticeable when the cotyledons take the form of numerous small leaves assembled round a common axis, while the stem, developing gradually from their midst, bears the succeeding leaves singly, round about itself. This can be observed to perfection in the growth of conifers. Here the wreath of needles forms, as it were, a calyx. We shall have to recall these cases in connexion with similar phenomena which we shall meet later.

121. Soret ed., p. 9, translates this incorrectly as "aussi épais que longs". (A.A.)

§ 17

We will not now occupy ourselves with the single cotyledons of indefinite form belonging to those plants which germinate with one leaf.

§ 18

We will, however, notice that even the most leaf-like cotyledons themselves are always relatively undeveloped as compared with the later leaves of the shoot. Their outline, especially, is extremely simple, and bears as little trace of indentations as their surfaces do of hairs or other vessels (Gefässe)[122] characteristic of the mature leaf.

II. DEVELOPMENT OF THE STEM-LEAVES FROM NODE TO NODE

§ 19

We are able now to study accurately the successive formation of the leaves, since the progressive operations of Nature all take place, step by step, under our eyes. A variable number of the succeeding leaves are often already present within the seed, and lie enclosed between the cotyledons; while still in their folded condition they are known under the name of the plumule. The relation of their form to that of the cotyledons and of the following leaves differs in different plants, but they generally diverge from the cotyledons in being expanded and thin in texture; on the whole fashioned as typical leaves; fully green in colour; and attached to an obvious node. Their relationship to the later stem-leaves is indubitable, but they are commonly inferior to them in the fact that their periphery or margin has not reached its full elaboration.

§ 20

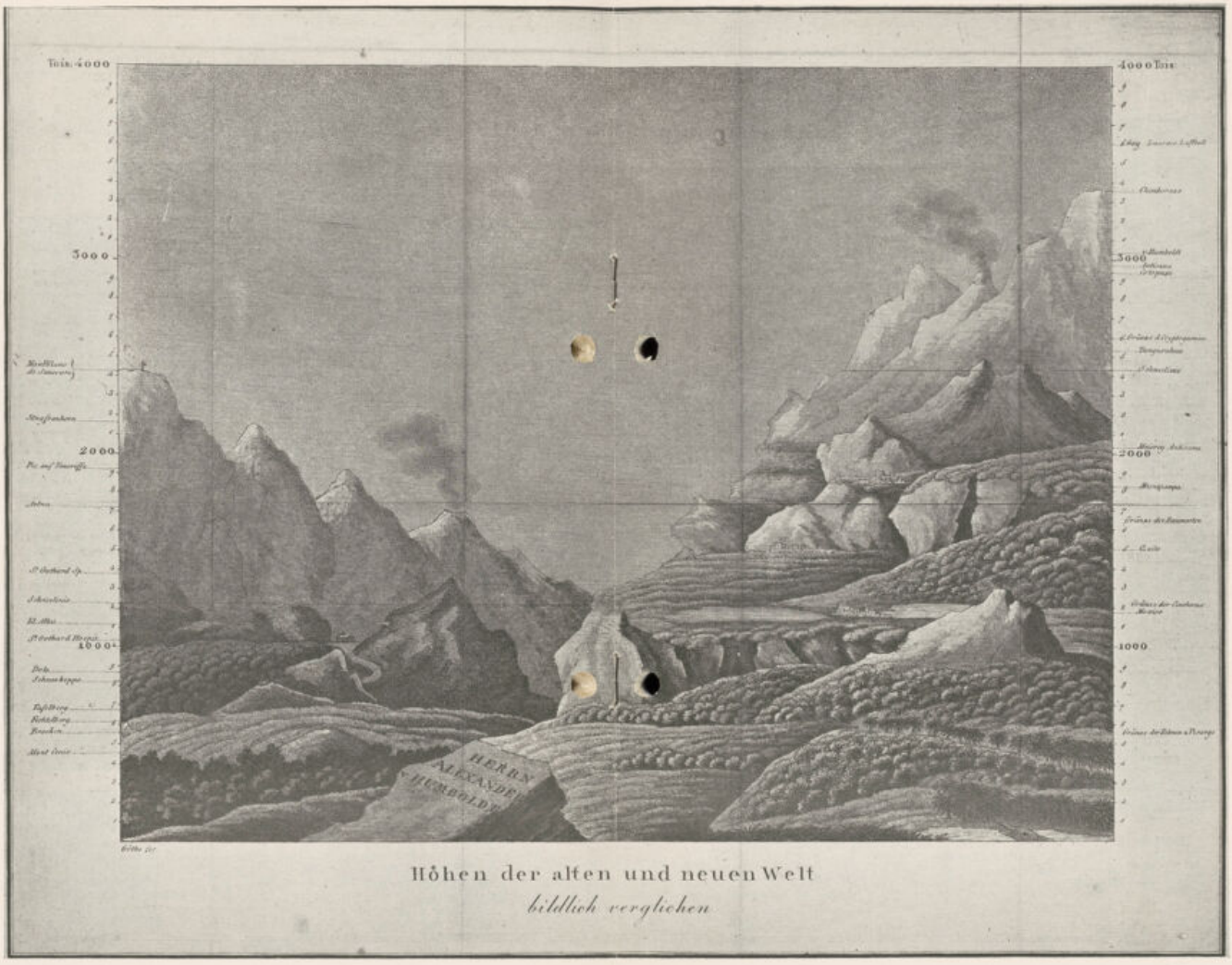
The leaf shows a continuous development from node to node, as the midrib elongates, and the lateral veins arising from it stretch out more or less on either hand. The various characters of the nervation are the principal cause of the multifarious forms met with in leaves. Leaves may be indented, deeply incised, or formed of many leaflets; in the last case they prefigure complete small shoots. The date palm affords a striking example of such graded diversification of the simplest leaf form. In a sequence of several leaves, the midrib is carried progressively further into the lamina; the fan-like simple leaf becomes torn and divided; and the end result is a highly complex leaf, vying with a branch.

§ 21

As the leaf itself arrives at the perfection of its form, so the leaf-stalk also develops correspondingly; it may either make a continuous whole with its leaf, or it may form a distinct stalklet, easily detachable at a later stage.

122. Goethe uses *Gefässe* as a vague general term for anatomical elements forming the leaf (*cf.* also § 25). *See* Sachs, J. von (1890): *History of Botany.* Trans. by Garnsey, H. E. F. and Balfour, I. B., Oxford, p. 254, for the indefinite use of the word vessel in the eighteenth century. (A.A.)

Abnormal, funnel-shaped, spirally contorted shoot of Valeriana officinalis L., from Taf. 5 (cf. p. 72) of Schuster, J. (1924): l.c., after Stark's drawing from a sketch by Goethe. (See p. 79 of text.)



Höhen der alten und neuen Welt

bildlich verglichen

Diagrammatic landscape to illustrate comparative altitudes in the Old and New Worlds, drawn by Goethe to illustrate von Humboldt's *Ideen zu einer Geographie der Pflanzen, nebst einem Naturgemälde der Tropenländer* reproduced from Allg. Geogr. Ephemeriden, vol. xli, pp. 5-8 (1813).

Goethea cauliflora H. et M., type species of the genus Goethea, after Jh. Wild's drawing in Nova Acta, vol. 2, pl. viii.

§ 22

We see in various plants, for example the orange tribe[123], that this independent leaf-stalk may also have a tendency to transform itself into a leaf-like form. The organisation of such leaf-stalks will in the sequel suggest some considerations to us, which we will put aside for the present.

§ 23

Neither can we now enter upon a special investigation of stipules; we only remark in passing that, especially when they form part of the leaf-stalk, they also become remarkably transformed in the course of its further change.

§ 24

Now as the leaves owe their first nourishment principally to the more or less modified watery fluid which they draw from the stem, so they are indebted to the air and the light for their main development and elaboration. As we find the cotyledons, produced within the closed seed coat, charged as it were with a crude sap only, and organised and developed scarcely at all, or merely in a rough fashion; so the leaves of plants which grow under water are of less perfect organisation than those exposed to the open air. Again, the same plant species develops smoother and less highly perfected leaves when it grows in low and damp places; if on the contrary it is transferred to a higher situation, it produces leaves which are rough, hairy, and more elaborately formed.

§ 25

The vessels[124] which form the skin of the leaf, and which arise from the ribs and feel their way towards one another by their tips, are similarly influenced; their anastomosis, if not altogether caused, is at least much promoted by the more subtle kinds of gas. We are inclined to ascribe to lack of complete anastomosis the fact that the leaves of many plants which grow under water are thread-like or antler-like. The mode of growth of the water buttercup (*Ranunculus aquatilis* L.)[125] affords us clear evidence on this point, since its leaves produced under water have thread-like ribs, while those developed above the water surface are formed with fully anastomosed and entire blades. Indeed the transition can be accurately traced in leaves of this plant which are partly anastomosed and partly thread-like.

§ 26

It has been learnt experimentally that the leaves of plants absorb different gases and combine them with their internal moisture; nor does any doubt remain that they return these refined saps to the stem, and thus greatly promote the growth of the neighbouring buds. The kinds of gas developed from the leaves of many plants, and also from the cavities of reeds[126], have been investigated with convincing results.

---

123. In a letter to Soret, July 14, 1828 (Uhde, H. (1877): *l.c.*, p. 51) Goethe says that he used *Agrumen* (the word employed in § 22.) for "die ganze Sippschaft der Citronen, Pommeranzen u.s.w." (A.A.)

124. *See* note to §18. (A.A.)

125. Goethe uses the name *Ranunculus aquaticus*. (A.A.)

126. The expression "Hölungen der Rohre" used here is translated "cavités des joncs" by Soret; "vaisseaux" by Gingins-Lassaraz and Martins; and "hollow stems" by Cox. (A.A.)

§ 27

We observe in various plants that one node springs from another. In stems which are closed at the nodes[127], as in cereals, grasses, and reeds, this is obvious to the eye; but it is less conspicuous in other plants which have a hollow centre throughout, and appear to be filled with a pith or rather a cellular tissue. The rank, among the other anatomical regions of the plant, formerly held by the so-called pith is now however disputed[128], and, as it seems to us, on excellent grounds. Its apparently predominant influence in growth is denied, while all impetus and developmental force is, on the other hand, ascribed unhesitatingly to the inner face of the second cortex — the so-called *liber*. It thus becomes more convincing that an upper node — since it arises from the one below, and receives the sap by its mediation in a finer and more filtered state, improved by the action of the preceding leaves — must develop more perfectly and convey more delicate juices to its own leaves and buds.

§ 28

Since now the cruder saps are continually drained in this manner, and give rise to purer — the plant meanwhile perfecting itself step by step — the period prescribed by Nature is finally reached. At last we see the leaves in their greatest expansion and development, and soon afterwards we become aware of a new aspect which warns us that the epoch which hitherto we have been studying is past, and a second is approaching — the epoch of the *Flower*.

III. TRANSITION TO THE FLOWERING PHASE[129]

§ 29

We see the transition to anthesis come to pass either *relatively rapidly* or *relatively gradually*. In the latter case we commonly notice that the stem-leaves begin to draw in, as it were, from the periphery, and especially to lose their diverse marginal divisions, while, on the other hand, they show some expansion in their basal regions, where they are connected with the stem. At the same time we see that, even if the stem interval from node to node does not elongate markedly, nevertheless it is much more delicately and slenderly formed than in its earlier state.

§ 30

It has been observed that copious nourishment hinders the production of the inflorescence of a plant, while a moderate or indeed scanty supply of food hastens it. The action of the stem-leaves, considered above, shows itself here still more clearly. So long as cruder saps are still to be carried away, so long must there be production of those organs which are capable of fulfilling this need. If excessive nourishment is forced upon the plant, this operation must be continually repeated, and flowering is thus rendered well-nigh impossible. If, on the other hand, the plant is deprived of food,

127. Goethe's expression is "von Knoten zu Knoten geschlossen," but the examples he gives suggest that he actually meant "closed at the nodes". (A.A.)
128. Hedwig, Leipziger Magazin, Part III. (For full reference *see* p. 71 (A.A.))
129. The word which I have translated "flowering phase" is "Blüthenstand"; Goethe uses this term indifferently for inflorescence and for flower. (A.A.)

this natural process is facilitated and shortened; the foliar organs are refined, the operation of the unadulterated saps becomes purer and stronger, and the transformation of the parts is rendered possible and makes unimpeded progress.

IV. FORMATION OF THE CALYX

§ 31

We often see the change to the flowering phase occur *rapidly*, and in this case the stem, above the node of the uppermost leaf, suddenly becomes tall and slender, while several leaves are gathered together at its apex, grouped around a centre.

§ 32

It may, it seems to us, be proved most clearly that the leaves of the calyx are the same organs as those which up to the present have developed as stem-leaves, but are now, often in very different guise, collected round a common centre.

§ 33

We have already among cotyledons noticed a similar operation of Nature, and have seen several leaves, and thus clearly several nodes, collected round a point and approximated. The conifers, when they develop from the seed, show a radiating wreath of unmistakable needles, which, unlike the generality of other cotyledons, are already highly developed. We thus see, in the first infancy of this plant, an indication, as it were, of that power of Nature through which, at a greater age, inflorescence and infructescence will be produced.

§ 34

Further we see in various flowers unaltered stem-leaves collected into a kind of calyx immediately beneath the corolla. Since their form is completely characteristic, we need only, in proof of their being leaves, appeal to ocular evidence and to botanical terminology, which has distinguished them by the name of floral leaves, *Folia floria*.

§ 35

We have to observe with greater attention the case already mentioned, in which the transition to the inflorescence occurs *gradually*. Here the stem-leaves approach one another little by little, become transformed, and by degrees, as it were, pass into the calyx, as may easily be observed in the calyx[130] of the composites, especially the sunflowers and the marigolds.

§ 36

This faculty of Nature, which assembles a number of leaves round a centre, may be observed to bring about an even more intimate union, thus making these collected and modified leaves still less recognisable; for it unites them between themselves — sometimes completely, but often only partially — inducing concrescence of their lateral margins. The leaves — so closely crowded and pressed against one another — are most intimately

130. This, which Goethe calls "Kelch," is now described as an involucre of bracts. (A.A.)

in contact in their embryonic condition; they anastomose through the influence of the extremely pure sap present by this time in the plant, and appear before us as the bell-shaped or so-called one-leaved (monosepalous) calyx, which reveals its compound origin by the fact that its upper margin is more or less toothed or incised. We can find ocular evidence of this if we compare a number of deeply cut calyces with those that are many-leaved, especially when the calyces of various composites are exactly considered. We shall see, for example, that the calyx of the marigold, which in systematic descriptions is called *simple* and *much divided*, consists, in reality of many concrescent and superposed leaves, into which, as we have already mentioned, the contracted stem-leaves pass, as it were, almost insensibly.

§ 37

In many plants there is constancy in the number and form in which the sepals, whether free or fused, and the succeeding members are arranged round the stalk as an axis. On this constancy depends, in great part, the progress, the trustworthiness, and the repute of botanical science, which we of late have seen increasing more and more. In other plants the number and structure of these members is not equally constant, but even this inconstancy has been unable to baffle the delicate powers of discrimination of the master workers in this science; their endeavour has been by exact diagnosis to limit these anomalies of Nature, as it were, to a narrower sphere.

§ 38

In this way, then Nature formed the calyx: she *connected together* round a centre several leaves and consequently several nodes, generally according to a certain definite number and plan; these leaves and nodes she would otherwise have produced *successively and at some distance from one another*. If the flowering had been inhibited by the intrusion of superfluous nourishment, these leaves would have been spaced out, and would have appeared in their earlier form. Thus in the calyx Nature produces no new organ, but she unites and modifies only the organs already known to us, and in this way achieves a step towards the goal.

V. FORMATION OF THE COROLLA

§ 39

We have seen that the calyx owes its origin to elaborated saps, which are engendered by degrees in the plant, and that it is thus in its turn adapted for the production of a future organ of a further refinement. This idea can be confirmed when we interpret the process on purely mechanical grounds. For how extremely delicate, and suited to the finest filtration, those vessels must become, when they, as we have seen above, are in the closest contact and appressed to one another.

§ 40

We may observe the transition from calyx to corolla in more than one case; for although the colour of the calyx is still usually green, and remains similar to the colour of the stem-leaves, yet it often changes in one or other

of its regions — at the apices, margins, or back, or over its inner surface — while the outer still remains green; and we always see an increase of delicacy associated with this coloration. In this way ambiguous calyces come into being, which may equally well be taken for corollas.

§ 41

We have now remarked that from the cotyledons onwards there is a great extension and elaboration of the leaf, affecting its periphery in particular. Thence to the calyx there is a contraction of the outline, while, with the development of the corolla, we notice that a phase of expansion again sets in. The petals are generally larger than the sepals, and it is to be observed that the organs which were in a state of contraction in the calyx, at the stage now reached expand themselves as petals through the influence of purer saps, filtered through the calyx and in a high degree refined. They assume the appearance of entirely different organs, and their exquisite texture, their colour, and their scent, would quite obscure their origin for us, if it were not that in various exceptional cases we can spy out Nature's ways.

§ 42

So, for example, within the calyx of a pink, a second calyx is frequently found, which in part is fully green, and belongs to the type of the monophyllous toothed calyx, while in part it is laciniated, and, at its apices and margins, transformed into genuine beginnings of petals — delicate, expanded and coloured. Through such a case we once more clearly recognise the relationship of the corolla to the calyx.

§ 43

The relationship of the corolla to the stem-leaves is demonstrated to us in more than one manner; for in various plants stem-leaves occur which are already more or less tinted, long before they approach the inflorescence, while others, in the neighbourhood of the inflorescence, are completely coloured.

§ 44

It also frequently happens that Nature proceeds direct to the corolla, as it were skipping the calyx. In this case we likewise have the chance of observing that stem-leaves may pass into petals. So, for example, an almost completely developed and coloured petal may often be found on the stem of a tulip. A still more remarkable case is that in which such a leaf is half green, with its green half, which belongs to the stem, remaining attached thereto, while its coloured half is carried up with the corolla, so that the leaf is torn into two parts.

§ 45

It is a very probable idea that the colour and scent of the petals are to be attributed to the presence in them of the male fertilising substance[131]. Probably this substance occurs in them in a state in which it is not yet sufficiently isolated, but mixed and diluted with other juices. The beautiful phenomena of colour lead us to the conception that the material wherewith

131. The *Journal of Botany* version (Cox) translates this as "pollen," which does not render GOETHE's expression, "männlichen Samens" accurately. (A.A.)

the petals are filled, though indeed it has achieved a high degree of purity, yet still has not reached the highest grade, in which it appears to us white and colourless.

VI. FORMATION OF THE ANDROECIUM

§ 46

The theory suggested in the preceding paragraph seems still more probable when we consider the near relationship of petals and androecium. Were the relationship of all the other parts to one another so obvious, so generally observed, and so indubitably settled, the present treatise might be held to be superfluous.

§ 47

Nature in some cases shows us this transition in the normal course of development, *e.g.* in *Canna*, and various plants of this family. A true petal, little changed, contracts in its upper margin, and an anther, in connexion with which the rest of the petal takes the place of a filament, makes its appearance.

§ 48

In flowers which are often double, we can observe this transition in all its stages. In several kinds of rose, within the fully developed and coloured petals, there are others which are contracted, sometimes in the middle and sometimes at the side; this contraction is caused by a little callosity, which appears as a more or less complete anther, while, in a degree corresponding to the degree of contraction, the leaf approaches the simpler form of a stamen. In some double poppies, fully developed anthers are borne upon little-changed petals of the strongly double corolla, while in others, anther-like callosities induce more or less contraction of the petals.

§ 49

If all the stamens are changed into petals, the flowers become sterile; but if in a flower, while it becomes double, staminal development still occurs, fertilisation takes place.

§ 50

And so an androecium arises, when the organs which we have hitherto seen expanded as petals, reappear in a highly contracted and, at the same time, a highly refined condition. The opinion propounded above is thus once more confirmed, and we are made more and more aware of this alternating process of contraction and expansion, whereby Nature ultimately attains her end.

VII. NECTARIES

§ 51

Abrupt as is the transition in many plants from the corolla to the androecium, yet we notice that Nature does not always make the passage in a single stride. On the contrary, she produces intermediate organs, which in form and function sometimes approach one member and sometimes the other. Although the structure of these intermediate organs varies greatly,

yet they can generally be brought together under the one conception that they are *gradual transitions between the petals*[132] *and the stamens.*

§ 52

Most of the variously formed organs, which Linnaeus distinguished with the name of Nectaries, may be grouped under this definition; and here we find an additional reason for admiring the keen insight of that extraordinary man, who, without having a quite clear idea of the function of this part, yet trusted to a presentiment, and took the risk of calling by the same name organs which were very diverse in appearance.

§ 53

Various petals show their relationship with the stamens by the fact that, without markedly changing their form, they bear little grooves or glands, which secrete a honey-like sap. That this is a fertilising fluid, though still imperfect and incompletely determinate, may be conjectured from the considerations already advanced, and this conjecture will reach a still higher degree of probability, for reasons which we will bring forward later.

§ 54

The so-called nectaries may also appear as independent members, and then they sometimes approach petals in their structure, and sometimes stamens. For example, the thirteen rays of the nectaries of the grass of Parnassus (*Parnassia*), with their corresponding number of red globules, are closely similar to the stamens. Others show themselves as filaments without anthers, as in *Vallisneria* and *Fevillea*. We find them in *Pentapetes* regularly alternating with the stamens in one whorl, but foliar in form; in systematic descriptions they are called petal-shaped emasculated filaments (*filamenta castrata petaliformia*). Just such forms, oscillating between the categories[133], are seen in *Kiggellaria* and the passion flower.

§ 55

Those peculiar organs — *coronas* — likewise seem to us to deserve the name of nectaries, in the sense defined above. For if the formation of petals is brought about through an expansion, so the corona is formed, on the contrary, through a contraction — that is to say, in the same way as the stamens. Thus we see smaller, restricted coronas succeeding the completer, more extended corollas, as for example in narcissus, oleander (*Nerium*), and agrostemma (*Lychnis coronaria* Desr.).

§ 56

Yet other still more striking and remarkable transformations of petals are to be seen in different genera. We notice in various flowers that their petals, on the inner surface at the base, have a small hollow, which is filled with a honey-like sap. This pit, when it becomes deeper in other genera and species, produces a spur- or horn-like prolongation from the back of the petal, and the form of the rest of the petal is correspondingly more or

132. Though the word "Kelchblätter" is here used, and is translated "feuilles du calice" by SORET, it seems to be an obvious slip for "Kronenblätter". (A.A.)

133. This translation though rather free, seems to convey the sense of "schwankende Bildungen". (A.A.)

less modified. We may observe this particularly in various species and varieties of the columbine (*Aquilegia*).

§ 57

This organ is found in the highest degree of modification, for example, in monkshood (*Aconitum*), and love-in-a-mist (*Nigella*), in which, however, a little attention reveals its foliar character; in *Nigella,* especially, the nectaries readily grow out again into petals, and the flowers become double through their transformation. In *Aconitum,* on careful inspection, the similarity of the nectaries to the hooded petals which enclose them can be detected.

§ 58

Having propounded the idea that the nectaries are approximations of the petals to the stamens, we may now take the opportunity to make some remarks about irregular flowers. So, for example, the five outer leaves of *Melianthus*[134] may be considered as true petals, but the five inner may be described as a corona, consisting of six nectaries, of which the uppermost approaches most nearly to petal form, while the furthest divergence is shown by the lowermost, which is indeed already called a nectary. In just the same sense, the keel (*carina*) of the papilionaceous flower may be called a nectary, since it is the one amongst the petals which most nearly approaches stamen form, and departs very widely from the leaf shape of the so-called standard (*vexillum*). In this manner we can quite easily explain the brush-like bodies which are found attached to the extremity of the keel in some species of milkwort (*Polygala*), and we can come to a clear idea as to the category to which this keel should be assigned.

§ 59

It is surely unnecessary to make the emphatic reservation that the intention of these remarks is not to introduce confusion into a subject which has been already subdivided and pigeon-holed by the efforts of observers and systematists. The writer wishes only to make the variations of plant form more comprehensible through the considerations here advanced.

VIII. FURTHER NOTES ON THE ANDROECIUM

§ 60

Microscopic observations decide beyond all doubt that the reproductive organs of plants, like their other parts, are produced by means of the spiral vessels. We thence deduce an argument for the inner identity of the various members of the plant, which hitherto have appeared to us in such multifarious forms.

§ 61

Now since the spiral vessels lie in the centre of the sap-vessel-bundles, and are enclosed by them, we may picture the condition of strong contraction somewhat more exactly if we imagine the spiral vessels — which appear to us indeed as elastic springs — in their state of utmost energy; they are then dominant, whereas the expansion of the sap-vessels is subordinated.

134. On this case *see* Troll ed., p. 457. (A.A.)

§ 62

The abbreviated vascular bundles can now extend no more; they can no longer seek out one another, and no longer form a network through anastomosis; the tubular vessels, which otherwise fill up the interstices of the network, can no longer develop. All factors which have caused the expansion of the stem-leaves, sepals, and petals, vanish completely at this point, and a weak and extremely simple filament arises.

§ 63

The delicate membranes of the anther, between which the excessively tender vessels come to an end, are scarcely able to develop. If we now admit that at this stage those very vessels, which would otherwise have elongated, broadened, and again sought one another out, are at present in an extremely contracted condition; if we now see the highly elaborated pollen proceed from them, which compensates through its activity for what the vessels which produce it have lost in expansion; if it is at last set free and seeks out the female organ, which, through a natural correlation, occurs in the neighbourhood of the stamens; if it firmly adheres to this organ and communicates its influence to it: there is nothing then to prevent our calling the union of the two sexes an immaterial anastomosis, and believing that, at least for a moment, we have brought nearer together the concepts of growth and of reproduction.

§ 64

The delicate substance which develops in the anthers appears to us as a powder; but these pollen-grains are only vessels in which an extremely fine sap is stored. Hence we agree with the opinion of those who hold that the sap is imbibed by the pistils to which the pollen-grains adhere, and that thus fertilisation is brought about. This is the more probable since some plants secrete no pollen, but only a mere fluid.

§ 65

We recall to ourselves at this point the honey-like sap of the nectaries, and its probable relationship with the elaborated fluid of the seminal globules. Perhaps the nectaries are organs the function of which is preparation; perhaps their honey-like moisture is absorbed by the stamens, made more specific, and worked up fully — an opinion which is the more likely since after fertilisation this sap is no longer observable.

§ 66

We may just notice in passing that in some cases filaments, and, in others, anthers are concrescent, and offer us the most wonderful examples of the anastomosis and union of plant members which in their origin were truly distinct — a feature to which we have already more than once alluded.

IX. FORMATION OF THE STYLE

§ 67

As up to the present I have endeavoured as far as possible to make clear the inner identity of the various successively developed plant members, despite the very great deviations in their external form; so it will readily be conjectured that my object at this point is to explain the structure of the female organ in the same way.

§ 68

We will first of all consider the style apart from the fruit, as we indeed often find it in nature; and we can do this the more readily since in this form it shows itself distinct from the fruit.

§ 69

We notice, then, that the style remains at that stage of growth which characterises the stamens. We were able in fact to observe that the stamens originated through contraction. The styles are often in the same case, and we find them, if not always of similar dimensions to the stamens, still only to a small extent longer or shorter. In many examples the style is almost like a filament without an anther, and the relationship of their external form is closer than that of the other members. As they are both produced from spiral vessels, we see the more clearly that the female member has as little claim as the male to be regarded as an organ belonging to a special category; and if through this consideration we get a real insight into its exact relationship with the male, so we find the idea that fertilisation is a form of anastomosis the more pertinent and enlightening.

§ 70

We very often find the style produced by the concrescence of several distinct styles, while the members of which it consists can scarcely be distinguished, for not even at the tip are they always separated. This process of concrescence, the operation of which we have often noticed, is here even more possible than elsewhere; indeed it cannot but happen, since the delicate rudiments, before their development is completed, are compressed one against another in the midst of the flower, and may form the most intimate connexions between themselves.

§ 71

Nature shows us more or less clearly in various normal cases, the close relationship of the style with the preceding parts of the flower. So, for example, the pistil[135] of iris with its stigma presents to our eyes the complete form of a petal. The umbrella-shaped stigma of *Sarracenia* does not reveal itself so strikingly as compounded of several leaves, but its green colour does not discredit the idea. And with the help of a lens we find that various stigmas, such as those of crocus and *Zannichellia,* take the form of complete monophyllous or polyphyllous calyces.

§ 72

In retrograde development, Nature often shows us the case of styles and stigmas being again changed into petals; *Ranunculus asiaticus,* for example, becomes double by transformation of the stigmas and pistils of the female organ into veritable petals, while the stamens directly under this corolla are often unchanged. Some other significant instances will be cited below.

§ 73

We may recapitulate here the remarks made above, that styles and filaments represent corresponding phases of growth, and thereby once more

135. GOETHE uses the word "Pistill", but he is probably not including the ovarian region. (A.A.)

illustrate the principle of alternating expansion and contraction. From the seed to the fullest development of the stem-leaves, we first noticed an expansion. After this we saw the calyx arise through a contraction; the petals through an expansion; the sexual organs once more through a contraction; and we shall soon become aware of the extreme of expansion in the fruit, and the extreme of concentration in the seed. In these six steps Nature in unresting sequence completes the eternal work of the bisexual reproduction of plants.

X. CONCERNING THE FRUITS

§ 74

We shall now have to observe the fruits, and we shall soon convince ourselves that they have the same origin as the other organs, and are subject to the same laws. We are speaking particularly of those seed-vessels which Nature forms to enclose the so-called covered seeds—or, rather, from the inner surface of which she develops a larger or smaller number of seeds as the result of fertilisation. That these seed-vessels are likewise to be explained from the nature and organisation of the members hitherto considered, can also be shown in a few words.

§ 75

Retrograde metamorphosis, again, brings this law of Nature home to us. So, for example, in the pinks — flowers which are well known and loved for their very degeneracy — it may often be noticed that the seed-capsules change back into calyx-like leaves, and that the styles shorten correspondingly. Indeed pinks occur in which the seed-vessel has changed into a calyx, real and complete, while its apical teeth still bear the delicate remains of the styles and stigmas, and, from the interior of this second calyx, a more or less perfect corolla is produced in place of the seeds.

§ 76

Further, Nature has herself in very diverse ways revealed to us, in forms regularly and constantly recurrent, the fruitfulness which lies concealed in the leaf. So the modified, but still completely recognisable, leaf of the lime tree, produces from its midrib a little stalk bearing a complete flower and fruit. In the butcher's broom (*Ruscus*) the manner in which flowers and fruit are borne on the leaves is still more striking.

§ 77

The direct fertility of the stem-leaves in the ferns strikes one as still more intense, and as almost monstrous. These leaves through an inner impulsion, and perhaps without the definite interaction of two sexes, develop and shed countless seeds, or rather gemmae, capable of growth. Here a leaf vies in fruitfulness with a spreading plant, or with a large and branching tree.

§ 78

Bearing these observations in mind, we cannot fail to recognise the leaf nature of the seed-vessels — notwithstanding their various forms, their special modification, and their relations among themselves. So, for example, the legume would be a simple folded leaf concrescent by its margins, while

siliquas would consist of several leaves, superposed and fused. Compound seed-vessels would be explained as consisting of several leaves united round a middle point, their inner faces open towards one another, and their margins united. We may convince ourselves of this by observing the appearance presented when such aggregated capsules spring apart after ripening, since each member then reveals itself as an opened pod or siliqua. Moreover a similar process regularly occurs in different species of one and the same genus; for example, the fruit capsule of *Nigella orientalis* takes the form of partly concrescent legumes grouped round a centre, while in *N. damascena* (love-in-a-mist) they appear fully fused.

§ 79

Nature hides the leafy character from our sight most effectually when she forms sappy and soft, or woody and tough seed-cases; but she will not be able to escape our scrutiny when we know how to follow her carefully in all transitional phases. Here it may be enough to have indicated the general conception involved, and to have referred to some examples showing Nature's accordance with it. The extreme multifariousness of seed-vessels gives us material for further consideration in the future.

§ 80

The relationship of the seed-vessels to the preceding members shows itself also in the stigma, which in many cases is sessile and inseparably bound up with the seed-vessel. We have already indicated the affinity of the stigma with leaf form, and we may here refer to it once again; for in double poppies it may be noticed that the stigmas of the seed-capsule are transformed into delicate little coloured leaves, completely resembling petals.

§ 81

The last and most important expansion which the plant exhibits in its growth, shows itself in the fruit. Both in inner energy and in outer form this expansion is often very great, indeed enormous. Since the enlargement generally occurs after fertilisation, it appears that the seed, having entered upon its definitive development, since it draws upon the juices of the whole plant for its growth, gives them a trend towards the seed-case. With the help of these juices the vessels become nourished, dilated, and often in the highest degree filled and expanded. From the foregoing argument it may be concluded that the purer kinds of gas take a great share in this process; this idea is confirmed by the experimental fact that the distended legumes of *Colutea* (bladder senna) contain pure air.

XI. CONCERNING THE IMMEDIATE ENVELOPES OF THE SEED

§ 82

In contrast to the expansion of the fruit, we find that the seed shows the extreme degree of contraction, while its interior is highly elaborated. It may be noticed in various cases that the seed transforms leaves into its immediate integuments, and that it adjusts them more or less to itself — generally, indeed, by its own energy moulding them closely to itself and quite altering their form. Since we have already seen many seeds de-

veloped from a single leaf, and enclosed therein, we need not be surprised that an individual seed-embryo should clothe itself in a leafy integument.

§ 83

In many winged seeds we can detect indications of the leafy seed-coat not being perfectly fitted to the seed — for example in the maple, the elm, the ash, and the birch. A very remarkable example of how the seed-embryo gradually draws together more expanded sheaths and adjusts them to itself, is offered to us by the three differing zones of heterogeneously formed seeds in the marigold. The outermost circle still preserves a shape akin to that of the leaves of the calyx, except that a seed-rudiment, straining the midrib, induces a curvature of the leaf, and the concavity is divided lengthways into two parts by a membrane. The succeeding circle has suffered further change, the wings of the little leaf, and the membrane, having quite disappeared. The form, on the other hand, is somewhat less elongated, and the seed-rudiment at the back shows itself more distinctly, while the little protuberances, which it bears, are more conspicuous. These two series appear to be either not at all, or only imperfectly, fertile. To these succeeds the third series; it has the authentic, strongly curved form, with a completely fitting coat, fully developed in all its variegation of ridges and excrescences. Once more we see here a vigorous contraction of an expanded leaf-like member, induced through the inner activity of the seed, just as we previously saw the petal contracted through the influence of the anther.

XII. RECAPITULATION AND TRANSITION

§ 84

And thus we have followed in the steps of Nature as scrupulously as we may; we have accompanied the outward form of the plant in all its transformations, from its development out of the seed, until the seed arose again; and without pretending to disclose the first springs of Nature's action, we have directed our attention to the manifestation of the forces whereby the plant gradually transforms one and the same organ. In order not to lose hold of the thread which we have once grasped, we have throughout considered the plant only as an annual, and we have noticed only the transformations of the leaves associated with the nodes, and have derived all forms from them. But, in order to give this essay the necessary completeness, we must now speak of the *buds* which lie concealed beneath each leaf, and develop under certain conditions, while, under other circumstances, they apparently disappear entirely.

XIII. CONCERNING THE BUDS AND THEIR DEVELOPMENT

§ 85

Nature bestows on each node the power to produce one or more buds. This happens in the neighbourhood of the leaves investing it, which appear to prepare for the formation and growth of the buds, and to cooperate in these processes.

§ 86

Upon the successive development of one node from another, and the formation of a leaf at each node with a bud in its neighbourhood, depends the first simple, gradually progressive reproduction of vegetables.

§ 87

It is well known that the activity of such a bud has a great similarity to that of the ripe seed; and that often in the bud, still more than in the seed, the whole form of the future plant may be recognised.

§ 88

Although a point from which a root will originate cannot be observed in the bud with equal facility, still it is really present there, as in the seed, and develops rapidly and easily, especially under moist conditions.

§ 89

The bud needs no cotyledons, since it is in connexion with its mother plant, which is already fully organised, and out of which, so long as it is in union with it, it obtains sufficient nourishment. If the bud is separated from its parent, it draws its supplies from the new plant on which it is grafted, or if, as a branch, it is planted in the earth, through the roots which are promptly produced.

§ 90

The bud consists of nodes and leaves, more or less developed, which are able to carry the future growth further. The lateral branches, which spring from the nodes of plants, may be regarded, then, as individual plantlets which take their stand upon the body of the mother, just as the latter is fixed in the earth.

§ 91

The seed and the lateral branch have frequently been compared and contrasted, and especially with so much insight and accuracy not long ago, that we may content ourselves with referring to this work with unconditional assent[136].

§ 92

We will cite only this much: that, in highly organised plants, Nature distinguishes buds and seeds clearly from one another, but, if we descend to the less complex, the distinction between the two seems to vanish, even to the sight of the keenest investigator. There are indubitable seeds and indubitable gemmae; but the point at which the truly fertilised seeds (isolated from the mother-plant by the operation of the two sexes) coincide with the gemmae (which are directly derived from the plant and detach themselves with no obvious cause) may indeed be apprehended by the intellect, but in no way by the senses.

§ 93

This being well pondered, we may venture to infer that the seeds — which are distinguished from the buds by their enclosed condition, and from the gemmae by the evident cause of their formation and detachment — nevertheless are closely related to both.

---

136. GAERTNER, *De fructibus et seminibus plantarum.* Cap. I. [§ 92 also relates to this work by J. GAERTNER. On gemmae *see* vol. I, Stuttgart, 1788, *Introductio generalis,* Cap. I, p. xi, etc. (A.A.)]

XIV. FORMATION OF COMPOUND FLOWERS AND FRUITS

§ 94

We have hitherto sought to explain simple flowers, as likewise seeds which are enclosed in seed-vessels, through the transformation of nodal leaves. It will be found on closer investigation that in this case no buds develop — indeed the possibility of such a development is completely annulled. But in order to interpret both compound flowers and collective fruits borne around a single cone, a single spindle, a single disc, and so forth, we must call to our aid the development of buds.

§ 95

We frequently notice that stems, without preparing for some time, and holding themselves in reserve for a single flower, produce their flowers nodally, and often proceed thus continuously to their apex. But the phenomena thus displayed may be explained on the theory proposed above. All the flowers which develop from lateral buds are to be regarded as entire plants, which are set in the mother plant, as the mother plant is set in the earth. Since, under these circumstances, they receive purer saps from the nodes, so even the earliest leaves of the branchlets are indeed much more highly perfected than the first leaves of the mother plant which succeed the cotyledons; so much so that the formation of calyx and flower is often immediately possible.

§ 96

These same flowers, which are developed from lateral buds, would with increased nutrition have become branches, and would have experienced, in like manner, the fate to which the mother-stem, being in the same case, is obliged to submit.

§ 97

As now from node to node flowers of a similar kind develop, so we notice the same changes of the stem-leaves as we observed above in the gradual transition to the calyx. These stem-leaves gradually contract more and more, and finally dwindle almost completely. Since they then diverge more or less from leaf form, they are given the name of bracts. Correspondingly the stem becomes slenderer, the nodes become more closely set, and all appearances noticed above may be again traced here, except that no sharply defined inflorescence follows at the end of the stem, since Nature has exercised her right already from bud to bud.

§ 98

As we have now fully considered a stem adorned with a flower at each node, we shall be able to interpret a *collective inflorescence* quite easily, provided we call to our aid what has been said above about the origin of the calyx.

§ 99

Nature forms a *common calyx* from *many* leaves, which she crowds upon one another and collects round an axis. With the same strong growth impetus she modifies *an elongated stem,* as it were, in such a way that *all its*

buds are produced at once in the guise of flowers, thronged together in the closest possible proximity; each floret fertilises the seed-vessel already prepared below it. In this monstrous crowding, the nodal leaves do not invariably disappear; in the thistles the bract faithfully accompanies the floret, which develops from its associated bud. To illustrate this paragraph, the structure of the teasle (*Dipsacus laciniatus* L.) should be examined. In many grasses, each flower is accompanied by such a bract, which in this case is called the glume.

§ 100

In this way it will become apparent to us how it is that *the seeds developed by a composite flower are genuine buds, perfected and elaborated through the operation of the two sexes.* If we hold fast to this conception, and consider in this sense the growth and fructification of various plants, personal observation of a comparative kind will best convince us.

§ 101

It will then indeed not be difficult for us to explain the fructification of enclosed or exposed seeds, often collected round an axis, in the middle of a single flower. For it is all the same whether a single flower surrounds a complex fructification — the concrescent pistils absorbing the generative saps from the anthers of the flower and imbuing the seed with them — or whether each seed possesses its own pistil, its anthers, and its own corolla.

§ 102

We are convinced that with some practice there is no difficulty in explaining the multifarious forms of flowers and fruits in this way. It will admittedly be necessary for this purpose to operate with the conceptions of expansion and contraction, of compression and anastomosis, established above, as easily as with algebraic formulae, and to know how to use them in the right places. Now much depends upon the accurate observation and comparison with one another of the various stages which Nature follows, as well in the formation of genera, species, and varieties, as in the growth of a single plant; hence a collection of illustrations, arranged in order for this end, and an application of the botanical terminology of the various plant members, purely from this point of view, would be desirable, and certainly would not be without use. Two examples of proliferated flowers, giving strong support to the theories adduced, will, if demonstrated to the eye, afford crucial instances.

XV. PROLIFERATED ROSE

§ 103

All that we have hitherto sought to comprehend with the power of the imagination and intellect alone, is revealed with the greatest clearness in the example of a proliferated rose. Calyx and corolla are arranged and developed round the axis, but there is no *growth-inhibited*[137] seed receptacle in the centre, with the male and female reproductive organs placed *in orderly sequence* on it and around it; instead of this, the stalk, half *reddish* and half *greenish, elongates* again, while smaller petals develop upon it *in succession.*

137. This expression is used for GOETHE's "zusammengezogen". (A.A.)

These are dark red and folded on themselves, and some of them bear traces of anthers. The stem goes on growing, and prickles are seen on it again. The coloured petals which follow are spaced apart; they become smaller and merge before our eyes into partly red and partly green stem-leaves. A succession of regular nodes is formed, from the buds of which arise little rosebuds, which are, however, imperfect.

§ 104

This example gives us thus a visible proof of the considerations previously advanced; namely that all calyces are floral leaves, only united by their margins. For here the calyx, regularly arranged round the axis, consists of five completely developed compound leaves of three or five leaflets, just like those that are borne by the branches of roses at their nodes.

XVI. PROLIFERATED PINK

§ 105

After we have studied this phenomenon carefully, another, which is to be observed in a proliferated pink, will seem to us almost more remarkable. We see a complete flower, the calyx of which has a double corolla above it, terminating in the midst with a seed-capsule, which is, however, imperfect. From the sides of the corolla, four complete new flowers develop, separated from the mother-flower by means of stems with three or more nodes; like the mother-flower, they have calyces, and are doubled, but not so much by means of individual petals as, either by means of corollas, the claws of which are concrescent, or, more usually, by means of petals, which are united in branchlet form, and clustered round a stalk. Notwithstanding this monstrous development, the filaments and anthers are present in some. The seed-vessels with styles are to be seen, and the placental region[138] has again grown out into leaves. In one of these flowers the seed-envelopes[139] were associated into a complete calyx, containing, in its turn, the rudiment of a complete double flower.

§ 106

We have in the rose a flower, as it were, half perfected, out of the centre of which a stem again shoots forth, bearing on itself new stem-leaves. So we find in this pink that — in addition to a normally formed calyx, a complete corolla, and *a pistil in the very centre — buds develop from the region of the petals,* and display actual branches and flowers. Both cases then show us that Nature, in the ordinary course, carries growth to a conclusion in the flower, and as it were sums it up, so that — in order the more quickly to reach the goal through the formation of seeds — she puts a stop to the possibility of an indefinite and gradual progression.

XVII. LINNAEUS' THEORY OF ANTICIPATION

§ 107

If I have stumbled here and there on this road, which one of my predecessors, who sought it moreover under the guidance of his great teacher,

138. This expression is used as a possible equivalent for Goethe's "Receptakel der Samen". (A.A.)

139. The word "Samendecken" used here is translated "arilles" by Soret. (A.A.)

describes as full of terrors and perils[140]; if I have not levelled it sufficiently; nor succeeded in sweeping away all obstacles for my successors: I still hope not to have undertaken this labour fruitlessly.

§ 108

It is now time to take into consideration the theory which Linnaeus proposed for the interpretation of these very phenomena. The observations which prompted the present essay could not elude his keen glance. And if we are able to pass beyond the point at which he halted, we owe it to the common efforts of so many observers and thinkers, who have cleared away various impediments and have dissipated many prejudices. An exact comparison of his theory and that set forth above, would delay us too long. Experts will easily make the comparison for themselves, and to render it clear to those who have not previously attended to the subject, would involve too much detail. We will only indicate shortly what it was that prevented Linnaeus from progressing further and reaching the goal.

§ 109

He made his observations especially on trees — those complex and long-lived plants. He noticed that a tree in a large pot, supplied with excessive nourishment, produced branch after branch for several years in succession, while the same tree, cultivated in a smaller pot, rapidly brought forth flowers and fruit. He saw that the successional development in the former, suddenly became telescoped in the latter. Hence he called this process of Nature *Prolepsis,* an *Anticipation,* since the plant seemed to forestall six years in passing through the six steps to which we have alluded above. And so he worked out his theory in relation to the buds of trees, without paying any special regard to annual plants, since he must indeed have observed that to them it was less applicable. For according to his doctrine one needs to suppose that each annual plant must, intrinsically, have been destined by Nature to grow for six years, and that it all at once anticipates this long period of time in reaching the stage of flower and fruit, and thereupon dies.

§ 110

We, on the contrary, have first followed the growth of the annual plant; starting from this point, the application of the argument to perennial plants is easily made, since a bud shooting forth from the oldest tree is to be regarded as an annual plant, even if it develops directly out of a long-existent stem, and may itself be destined to a prolonged life.

§ 111

The second cause which hindered Linnaeus from advancing further, was that he visualised the various concentric zones of the plant body — the outer and the inner cortex[141], the wood, and the pith — too much as parts which acted equally, and were in an equal degree living and essential; and he as-

140. Ferber *in* Praefatione Dissertationis Secundae de Prolepsi Plantarum. [The full reference is Ferber, J. J. (1763): *Prolepsis plantarum, in* Linnaeus, C., *Amoenitates Academicae,* Lugduni Batavorum, vol. 6, No. cxx, *Praefatio,* p. 365. (A.A.)]

141. "Cortex" is used as a translation of "Rinde", but there is no exact English equivalent for this term, which, in Goethe's sense, includes epidermis, bark, cortex, phloem, and cambium. (A.A.)

cribed the origin of the flower- and fruit-members to these various zones of the stem, since these members, as well as the stem-zones, appear to enclose one another and to develop out of one another; but this was only a superficial observation, which will not endure closer scrutiny. For the outer cortex is not fitted for further development, and in long-lived trees it becomes, towards the outside, an indurated and isolated mass, as the wood becomes hardened towards the centre. In many trees the outer cortex is shed, and in others it may be removed without injuring them in the least. It cannot therefore bring forth either a calyx or any other living part of the plant. It is the second cortex[142] which possesses all the capacity for life and growth. If it is partially destroyed, to that degree growth is interrupted; it is the second cortex which, on careful consideration, we find produces all the exterior parts of the plant, either gradually in the stem, or all at once in the flowers and fruit. But only the subordinate function of producing the petals was ascribed to it by Linnaeus. The important production of the male staminal apparatus fell, on the other hand, to the wood; but it may easily be observed, on the contrary, that the wood itself is brought to a state of repose by its solidification, and, durable as it is, it is incapable of performing vital operations. The pith, finally, is supposed to accomplish the principal function, that of producing the female reproductive organs and a numerous progeny. The doubt which has been cast upon the great importance of the pith, and the reasons upon which this doubt is grounded, are to me weighty and decisive. The style and fruit present merely a superficial appearance of originating from the pith, because these structures, when they first make their appearance, are in a soft, ill-defined, pith-like, parenchymatous condition, and are crowded together just in the centre of the stem, where we are accustomed to see only the pith.

XVIII. SUMMARY

§ 112

I hope that the present attempt to interpret the metamorphosis of plants may contribute something to the solution of this enigma, and may give occasion for additional investigations and deductions. The scattered observations on which it is based have already been collected and arranged in order[143]; and it will soon be decided whether the step which we have here taken constitutes an approach to the truth. We will now as shortly as possible, summarise the principal results of the foregoing discourse.

§ 113

If we consider a plant in so far as it expresses its life force, we see that this force reveals itself in two directions — first, in *vegetative growth*, when it produces stem and leaves, and then in *reproduction*, which is completed in flower- and fruit-formation. If we inspect growth more closely, we see that, since the plant carries forward its existence from node to node and from leaf to leaf as it vegetates, a reproduction may be said to take place.

142. Goethe no doubt included what we now call the cambium in "die zweyte Rinde". (A.A.)

143. Batsch, Anleitung zur Kenntniss und Geschichte der Pflanzen. Theil I, Cap. 19. [For fuller reference *see* p. 70 (A.A.)]

This type of generation distinguishes itself, by the fact that it is *successive*, from the reproduction through the flower and fruit, which happens *suddenly;* being successive, it shows itself in a sequence of individual developments. This vegetative force, gradually expressing itself, bears an extremely close relation[144] to that which manifests itself once and for all in a conspicuous reproductive phase. A plant can be compelled, under various conditions, to *vegetate continuously,* while, on the other hand, one can *hasten the flowering phase.* The former result occurs when crude saps flood the plant; the latter when more rarefied forces predominate.

§ 114

When in this way we have named the *vegetative shoots* as representing successive reproduction, and *flower and fructification* as representing simultaneous reproduction, we have, in so doing, indicated the manner in which they both express themselves. A plant which *vegetates,* spreads itself more or less, and develops a stalk or stem; the intervals from node to node are generally noticeable; and its leaves spread out from the stem on all sides. On the other hand, a plant which *flowers* has contracted all its parts; increase in height and breadth is, as it were, arrested; and all its organs are in a highly condensed state and developed in close proximity to one another.

§ 115

When now the plant vegetates, blooms, or fructifies, so it is still *the same organs* which, with different destinies and under protean shapes, fulfil the part prescribed by Nature. The same organ which on the stem expands itself as a leaf, and assumes a great variety of forms, then contracts in the calyx — expands again in the corolla — contracts in the reproductive organs — and for the last time expands as the fruit.

§ 116

This operation of Nature is at the same time bound up with another — the *assembling of different organs round a centre,* according to definite numbers and proportions, which, however, in many flowers may often be, under certain circumstances, much modified and variously changed.

§ 117

In like manner in the *formation* of flowers and fruit an *anastomosis* operates, whereby the extremely delicate fructification parts, closely crowded against one another, are most intimately united, either throughout their whole duration, or only for part of this time.

§ 118

These phenomena of *approximation, arrangement round a centre*[145], and *anastomosis,* are not, however, peculiar to flowers and fructifications. We may, indeed, perceive something similar in cotyledons; and other plant members will give us ample material for similar considerations in the sequel.

§ 119

Just as we have now sought to explain the protean organs of the vege-

144. "Verwandt" misprinted "vewrandt" in the first issue of the first edition. (A.A.)

145. This expression is used for "Centralstellung", which is translated "concentrations" by Soret. (A.A.)

tating and flowering plant all from a single organ, *the leaf,* which commonly unfolds itself at each node; so we have also attempted to refer to leaf-form those fruits which closely cover their seeds.

§ 120[146]

It goes without saying that we must have a general term to indicate this variously metamorphosed organ, and to use in comparing the manifestations of its form; we have hence adopted the word *leaf.* But when we use this term, it must be with the reservation that we accustom ourselves to relate the phenomena to one another *in both directions.* For we can just as well say that a stamen is a contracted petal, as we can say of a petal that it is a stamen in a state of expansion. And we can just as well say that a sepal is a contracted stem-leaf, approaching a certain degree of refinement, as that a stem-leaf is a sepal, expanded through the intrusion of cruder saps.

§ 121

In the same way it may be said of the stem[147] that it is an expanded flowering and fruiting phase, just as we have predicated of the latter that it is a contracted stem.

§ 122

I have moreover at the conclusion of this essay considered the development of the *buds,* and through them have sought to explain compound flowers and unenclosed fruits.

§ 123

And in this way I have laboured to expound, as clearly and completely as I could, an idea which in my eyes has much that is convincing. If, in spite of all, it is still not fully in accordance with the evidence; if fault may still be found with it for some inconsistencies; and if the foregoing manner of interpretation does not seem to be universally applicable: so much the more will it be my duty to note all objections, and to treat this subject more exactly and circumstantially in the sequel, in order to make this way of looking at things more lucid, and to earn for it a more general approval than it can perhaps expect today.

146. The translation here given for the early part of this paragraph is made somewhat freely, in order to convey the meaning, which cannot be understood without reference to the previous paragraph. (A.A.)

147. One is tempted here and elsewhere to translate "Stengel" as "vegetative shoot," but to do so would modernise GOETHE's phraseology unduly. (A.A.)

THE OPENING OF A HORSE-CHESTNUT BUD (*Aesculus Hippocastanum* L.), PROBABLY AN ORIGINAL SKETCH BY GOETHE. — From SCHUSTER, J. (1924): *l.c.*, fig. 8, p. 100 (*See* p. 80 of text).

The

FRAGMENT

afterwards known as

Die NATUR

Sketch by Goethe, showing at the right, "Folge der Knoten" (sequence of nodes) and left, "Zusammenziehung" (the contraction from the stem-leaves to the calyx; on this contraction see p. 75 of text). — Sophien-Ausgabe, II, 13 (from Troll, W., 1926): *l.c.*, p. 143. (These and other scribbled notes by Goethe mentioned on p. 79 of text).

Prefatory Note: — A certain ode in prose, eventually called *Die Natur*, appeared in 1782, under the modest title, *Fragment*, in Part xxxii of the *Tiefurter Journal*. This was a magazine that circulated in manuscript among GOETHE's associates attached to the Weimar court; all the contributions were anonymous. The question of the authorship of *Die Natur* has been studied by RUDOLPH STEINER[148], and the information which he has collected from letters and other sources may be summarised briefly here. Shortly after Part xxxii of the *Tiefurter Journal* appeared, GOETHE (writing to KNEBEL, who had assumed that the poem was his composition), definitely denied that he was the author, but added that it was written by someone with whom he had often talked on such subjects. His denial was confirmed by CHARLOTTE VON STEIN, who, in a letter to KNEBEL, asserted that the author was TOBLER. There the matter seems to have rested until forty-five years later, when GOETHE — sixteen years after TOBLER's death — was reminded of the existence of the work by receiving a copy of it among papers which had belonged to the Duchess ANNA AMALIA; the script was that of an amanuensis whom he had employed in the seventeen-eighties. GOETHE seems at that distance of time to have forgotten his early disclaimer of the authorship of the *Fragment*, and he agreed to its being included among his published works. It appeared in the year after his death, under the title *Die Natur*, as the invocation to a volume containing some of his general scientific writings[149], but a letter, dating from the time that the manuscript came to light in 1828, was appended, in which GOETHE confessed frankly that he could not actually recall writing the poem. Despite CHARLOTTE VON STEIN's explicit statement, STEINER believes that TOBLER was in no sense the real author, but was, as it were, a reporter, recording aphorisms which he had heard from GOETHE in conversation. TREVELYAN, also, regards the work as a product of GOETHE's mind, if not of his pen[150]. It is difficult to accept these conclusions unreservedly, since little external evidence is presented for them, and the internal evidence points in the other direction. *Die Natur* seems too consistent and too closely integrated to have been put together piecemeal and at secondhand. A sub-title, *Aphoristisch*, which did not occur in the original, was added, presumably by GOETHE, when the work was to be printed. Its introduction was regrettable, since it seems to suggest that the stanzas are discrete entities, loosely assembled. This is what they might indeed have been if TOBLER had merely recorded disconnected dicta as they fell from GOETHE's lips; but to think of the ode, as it stands, as a collection of aphorisms does less than justice to its unity and coherence. Moreover TOBLER himself seems to have been the very man to have conceived and written such a poem. He is described as a scholar, steeped in learning and philosophy, with a strong bent towards the Greek

148. STEINER, R. (1892): *Zu dem "Fragment" über die Natur.* Schriften der Goethe-Gesellschaft, vol. 7, pp. 393-8.

149. GOETHE, J. W. VON (1833): *Werke*, vol. 50 (*Nachgelassene Werke*, vol. 10), Cotta, Stuttgart and Tübingen, pp. 1-7; it has been reprinted in Sophien-Ausgabe, Abt. II, Bd. 11, pp. 5-9; TROLL ed., pp. 107-9; etc.

150. TREVELYAN, H. (1941): *Goethe and the Greeks.* Cambridge, England; p. 113, footnote 3.

way of life. He was a Switzer, but in 1781 he spent six months in Weimar, where GOETHE had considerable contact with him, and became much attached to him. Before coming to Weimar, TOBLER had rendered SOPHOCLES into German verse, and, while he was there, he stimulated interest in the classics, especially by his translations of AESCHYLUS and EURIPIDES[151]. Since GOETHE thought highly of these versions, it may be concluded that TOBLER had a genuine poetic gift. He, like GOETHE, is known to have concerned himself with the Orphic hymns[152], which are said to date from the fourth century A.D., and among which there is one — *To Nature*[153] — which evidently played a part in inspiring *Die Natur*[154].

In *Die Natur* STEINER traces the germs of much of GOETHE's later scientific work, but this cannot be taken as a proof that GOETHE wrote the poem himself; it may mean, on the contrary, that TOBLER exerted a powerful influence upon his great contemporary.

Whatever conclusion expert students of GOETHE and TOBLER may eventually reach as to its authorship, *Die Natur* will remain of permanent interest to biologists, since, on GOETHE's own showing[155], it crystallises for us the phase through which his scientific philosophy was struggling in the years immediately preceding the experience of happy enlightenment which found expression in the *Metamorphose*[156].

A translation of *Die Natur* by T. H. HUXLEY formed the opening of the first volume of the British journal, *Nature*[157]; it was reprinted in the same periodical for the centenary of GOETHE's death[158]. Another translation, which HUXLEY regarded as an improvement upon his own[159], was made by BAILEY SAUNDERS[160]. The rendering which here follows the reprint of the text, owes much to both these versions.

The ode, as published in GOETHE's works, differs in minor points from the original, as here reprinted from the *Tiefurter Journal* after STEINER[161]. GOETHE's version includes one additional sentence[162].

---

151. TREVELYAN, H. (1941): *l.c.*, pp. 106 and 113.
152. PLASSMANN, J. O. (1928): *Orpheus. Altgriechische Mysteriengesänge.* Jena; p. iv.
153. A translation of this will be found in TAYLOR, T. (1896): *The Mystical Hymns of Orpheus.* London; pp. 28-33. The first edition of this work was published in 1787.
154. TREVELYAN, H. (1941): *l.c.*, pp. 63-4, 113-4, etc.
155. Letter to Kanzler F. T. A. H. VON MUELLER, May 24, 1828, Sophien-Ausgabe, Abt. II, vol. 11, pp. 9-12; TROLL ed., p. 447.
156. *See* also p. 80.
157. *Nature*, vol. 1, 1869, pp. 9-11.
158. *Nature*, vol. 129, 1932, pp. 425-6.
159. *Nature*, vol. 51, 1894, p. 1.
160. *The Maxims and Reflections of Goethe*, translated by [T.] BAILEY SAUNDERS, London, 1893, pp. 207-13.
161. STEINER, R. (1892): *l.c.*, pp. 258-61.
162. This sentence is given in footnote 164.

Original Text of the 'Fragment'*

Natur! Wir sind von ihr umgeben und umschlungen — unvermögend aus ihr herauszutreten, und unvermögend tiefer in sie hinein zu kommen. Ungebeten und ungewarnt nimmt sie uns in den Kreisslauf ihres Tanzes auf und treibt sich mit uns fort, biss wir ermüdet sind und ihrem Arme entfallen.

Sie schaft ewig neue Gestalten; was da ist war noch nie, was war kommt nicht wieder — Alles ist neu und doch immer das Alte.

Wir leben mitten in ihr und sind ihr fremde. Sie spricht unaufhörlich mit uns und verräth uns ihr Geheimniss nicht. Wir wirken beständig auf sie und haben doch keine Gewalt über sie.

Sie scheint alles auf Individualität angelegt zu haben und macht sich nichts aus den Individuen. Sie baut immer und zerstört immer und ihre Werkstätte ist unzugänglich.

Sie lebt in lauter Kindern, und die Mutter, wo ist sie? — Sie ist die einzige Künstlerinn: aus dem simpelsten Stoffe zu den grössten Contrasten: ohne Schein der Anstrengung zu der grössten Vollendung — zur genausten Bestimmtheit, immer mit etwas weichem überzogen. Jedes ihrer Werke hat ein eigenes Wesen, iede ihrer Erscheinungen den isolirtesten Begrif und doch macht alles eins aus.

Sie spielt ein Schauspiel: ob sie es selbst sieht wissen wir nicht, und doch spielt sie's für uns die wir in der Eke stehen.

Es ist ein ewiges Leben, Werden und Bewegen in ihr und doch rükt sie nicht weiter. Sie verwandelt sich ewig und ist kein Moment Stillestehen in ihr. Für's bleiben hat sie keinen Begrif und ihren Fluch hat sie an's Stillestehen gehängt. Sie ist fest. Ihr Tritt ist gemessen, ihre Ausnahmen selten, ihre Geseze unwandelbar.

Gedacht hat sie und sinnt beständig; aber nicht als ein Mensch sondern als Natur. Sie hat sich einen eigenen allumfassenden Sinn vorbehalten, den ihr niemand abmerken kann.

Die Menschen sind all in ihr und sie in allen. Mit allen treibt sie ein freundliches Spiel, und freut sich ie mehr man ihr abgewinnt. Sie treibt's mit vielen so im verborgenen dass sie's zu Ende spielt ehe sie's merken.

Auch das unnatürlichste ist Natur. Wer sie nicht allenthalben sieht, sieht sie nirgendwo recht.

Sie liebet sich selber und haftet ewig mit Augen und Herzen ohne Zahl an sich selbst. Sie hat sich auseinander gesezt um sich selbst zu geniessen. Immer lässt sie neue Geniesser erwachsen unersättlich sich mit zu theilen.

Sie freut sich an der Illusion. Wer diese in sich und andern zerstört, den straft sie als der strengste Tyrann. Wer ihr zutraulich folgt, den drükt sie wie ein Kind an ihr Herz.

Ihre Kinder sind ohne Zahl. Keinem ist sie überall karg, aber sie hat Lieblinge an die sie viel verschwendet und denen sie viel aufopfert. An's Grosse hat sie ihren Schuz geknüpft.

Sie sprizt ihre Geschöpfe aus dem Nichts hervor, und sagt ihnen nicht woher sie kommen und wohin sie gehen. Sie sollen nur laufen. Die Bahn kennt sie.

Sie hat wenige Triebfedern aber nie abgenuzte, immer wirksam immer manichfaltig.

Ihr Schauspiel ist immer neu weil sie immer neue Zuschauer schaft. Leben ist ihre schönste Erfindung, und der Todt ist ihr Kunstgrif viel Leben zu haben.

Sie hüllt den Menschen in Dumpfheit ein und spornt ihn ewig zum Lichte. Sie macht ihn abhängig zur Erde, träg und schweer und schüttelt ihn immer wieder auf.

Sie giebt Bedürfnisse weil sie Bewegung liebt. Wunder, dass sie alle diese Bewegung mit so wenigem erreichte. Jedes Bedürfniss ist Wohlthat. Schnell befriedigt, schnell wieder erwachsend. Giebt sie eins mehr so ist's ein neuer Quell der Lust. Aber sie kommt bald in's Gleichgewicht.

---

* As reprinted from the Tiefurter Journal, Pt. xxxii, 1782, by R. Steiner (1892), *l.c.*, pp. 258-261.

Sie sezt alle Augenblike zum längesten Lauf an und ist alle Augenblike am Ziele.

Sie ist die Eitelkeit selbst; aber nicht für uns denen sie sich zur grössten Wichtigkeit gemacht hat.

Sie lässt iedes Kind an sich künsteln, ieden Thoren über sie richten, tausend stumpf über sie hingehen, und nichts sehen und hat an allen ihre Freude und findet bey allen ihre Rechnung.

Man gehorcht ihren Gesezen, auch wenn man ihnen widerstrebt, man wirkt mit ihr auch wenn man gegen sie wirken will.

Sie macht alles was sie giebt zur Wohlthat, denn sie macht es erst unentbehrlich. Sie säumet dass man sie verlange, sie eilet, dass man sie nicht satt werde.

Sie hat keine Sprache noch Rede, aber sie schaft Zungen und Herzen durch die sie fühlt und spricht.

Ihre Krone ist die Liebe. Nur durch sie kommt man ihr nahe. Sie macht Klüfte zwischen allen Wesen und alles will sich verschlingen. Sie hat alles isoliret um alles zusammen zu ziehen. Durch ein paar Züge aus dem Becher der Liebe hält sie für ein Leben voll Mühe schadlos.

Sie ist alles. Sie belohnt sich selbst und bestraft sich selbst, erfreut und quält sich selbst. Sie ist rauh und gelinde, lieblich und schröklich, kraftlos und allgewaltig. Alles ist immer da in ihr. Vergangenheit und Zukunft kennt sie nicht. Gegenwart ist ihr Ewigkeit. Sie ist gütig. Ich preisse sie mit allen ihren Werken. Sie ist weise und still. Man reisst ihr keine Erklärung vom Leibe, truzt ihr kein Geschenk ab, das sie nicht freywillig giebt. Sie ist listig, aber zu gutem Ziele und am besten ist's ihre List nicht zu merken.

Sie ist ganz und doch immer unvollendet. So wie sie's treibt, kann sie's immer treiben.

Jedem erscheint sie in einer eigenen Gestalt. Sie verbirgt sich in tausend Namen und Termen und ist immer dieselbe.

Sie hat mich herein gestellt, sie wird mich auch heraus führen. Ich vertraue mich ihr. Sie mag mit mir schalten. Sie wird ihr Werk nicht hassen. Ich sprach nicht von ihr. Nein was wahr ist und was falsch ist alles hat sie gesprochen Alles ist ihre Schuld, alles ist ihr Verdienst.

Translation of the 'Fragment'

— Afterwards called by GOETHE 'Nature: Aphoristic' —

Nature! We are encircled and enclasped by her — powerless to depart from her, and powerless to find our way more deeply into her being. Without invitation and without warning she involves us in the orbit of her dance, and drives us onward until we are exhausted and fall from her arm.

Eternally she creates new forms. What now is, never was in time past; what has been, cometh not again—all is new, and yet always it is the old.

We live in the midst of her, and yet to her we are alien. She parleys incessantly with us, and to us she does not disclose her secret. We influence her perpetually, and yet we have no power over her.

It is as if she founded all things upon individuality, and she recks nothing of individuals. She builds for ever, and destroys for ever, and her atelier is inaccessible.

She lives in her children alone, and the mother, where is she? — She is the sole artist; from the simplest material she passes to the extremest diversity; with no hint of strain she arrives at the fullest consummation — at the exactest precision, always veiled in a certain obscurity. Each thing she makes has its own being, each of her manifestations is an isolated idea, and yet they all are one.

She acts a play; whether she witnesses it herself we know not, and still she acts it for us — for us whose view is but sidelong[163].

In her there is eternal life, eternal coming-to-be, and eternal movement, and yet she travels no further. She transmutes herself for ever, and for no moment does she come to rest. To abide unchanged is not in her scheme of things, and she has set her curse upon stagnation. She is constancy itself. Her pace is measured, she seldom endures exceptions, and her laws are immutable.

Pondering and meditation are perpetual in her; but it is not as humanity, but as Nature, that she muses. She reserves for herself an all-embracing mode of thought which none can penetrate.

All mankind is in her, and she is in them all. In friendliness she plays with each one, and rejoices the more he prevails against her. With many she deals so secretly that she plays the play out to the end before they are aware of it.

Even the extreme of the unnatural is Nature[164]. None can see her rightly anywhere who does not see her everywhere.

She loves her very self, and unto herself she cleaves eternally with countless eyes and hearts. She has set herself asunder, that she may be to herself the sources of gladness. Continually she produces new sentient beings who can enjoy her; inexhaustibly she communicates herself.

She takes delight in illusion. He who shatters it in himself and in other men, him she chastises as the harshest tyrant. He who follows her trustingly him she gathers to her heart like a babe.

Her children are innumerable. To none is she at all times miserly, but she has her favoured darlings for whom she is prodigal and to whom she dedicates much. To greatness she accords her protection.

She volleys forth her creations from nothingness, and tells them not whence they come nor whither they go. They have only to run the course she sets; knowledge of the way is hers alone.

Her springs of action are few, but they are never outworn; powerful are they always, and always rich in diversity.

Her drama is for ever fresh, since she continually creates new spectators. Life is her loveliest invention, and Death is her device for ensuring plenitude of Life.

She shrouds man in misty dark, and goads him incessantly towards the light; she makes him earthbound, inert, and ponderous, and ever and again she startles him out of sleep.

She arouses cravings, since she loves to incite. Marvellous it is that she achieves

---

163. This rendering, though not literal, conveys what I believe to be the sense of "die wir in der Eke stehen" (A.A.).

164. The sentence, "Auch die plumpste Philisterey hat etwas von ihrem Genie" (Even the crassest unenlightenment has in it something of her genius), was added here when the poem was printed among GOETHE's works.

this incitement with so little. Each longing which she instils is a benison; quickly appeased, quickly it springs up anew. If ever she gives more, it is a fresh fount of desire; but the balance is soon redressed.

Every moment she sets forth on the longest pilgrimage, and every moment she is at the end where she would be.

She is vanity itself, but not for us, for whom she becomes the soul of seriousness.

She allows every child to work its will upon her, every fool to sit in judgment upon her, and she permits thousands to pass over her in blind apathy; but she rejoices in them all, and from all she reaps her harvest.

We obey her laws even in resisting them; we work with her, even when our desire is to work against her.

Everything she gives becomes a blessing, since she begins by making it a necessity. She tarries, that we may long for her; she hastens, that we may not tire of her.

She has no speech nor language, but she creates tongues and hearts, through which she feels and utters.

Her ultimate perfection is Love; it is only through Love that she can be approached. She sets chasms between all beings, and in them all is the urge to interfuse. She has created severance, in order to draw all things together. She holds that a few draughts from the chalice of Love are a requital for a life full of care.

She is the Whole. To herself she metes out reward and punishment, delight and torment. She is austere and tender; charming and horrible; impotent and omnipotent. All things are evermore in her. Past and future are nought to her. The present is her eternity. Gracious is she. I laud her with all her works. She is wisdom and tranquillity. No answer to life's riddle can be wrested from her, no gift can be extorted from her which she does not offer of her own free will. She is full of finesse, but her goal is good, and it is best to avert the mind from her craft.

She is perfectly whole, and yet always incomplete. Thus, as she now works, she can work for ever.

To each man she appears as befits him alone. She cloaks herself under a thousand names and terms, and is always the same.

She has brought me hither, and will also lead me hence. I yield myself to her in trust. She may do with me as she pleases. She will feel no hatred towards her work. It is not I myself who have spoken concerning her. No—it is she who has said everything, both what is true and what is false. She is guilty of All, and hers is the honour of the Whole.

ARBER

Chronica Botanica, Volume 10, N

AGNES ARBER, D.Sc., F.

Author of 'Herbals', 'Water Plants: A Study of Aquatic Angiosp
'Monocotyledons: A Morphological Study', 'The Gramineae:
A Study of Cereal, Bamboo, and Grass', etc.

GOETHE'S
B

Single copies
of this number
$2.00

the Chronica

New York City, G
Inc.; Ottawa, Tho
Sucrs.; Bogotá ar
ternacional del
Caperan; Rio de Janeiro, Livraria Kosmos; São Pau
Civilização Brasileira; Buenos Aires, Acme Agency; L
Dawson & Sons, Ltd.; London, H. K. Lewis and Co., Ltd.; U
Lundequistska Bokh.; Groningen, N. V. Erven P. Noord
Librairie H. Le Soudier; Torino, Rosenberg & Sellier; Lisb
Sá da Costa; Moscow, Mezhdunarodnaja Kniga; Calcut
and Madras, Macmillan and Co., Ltd.; Johannesburg, C
Agency, Ltd.; Sydney, Angus and Robertson, Lt
Melbourne, N. H. Seward, Pty., Ltd.

CHRONICA BOTANICA, An International
Collection of Studies in the Method and History
of Biology and Agriculture, edited by FRANS VERD
• Volume 10, Number 2, Pages 63-126, Plates 23-2
(*Issued Summer* 1946)